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TEXTILE RESEARCH JOURNAL

VOL. XVI, No. 3 March, 1946

Cellulose Studies*

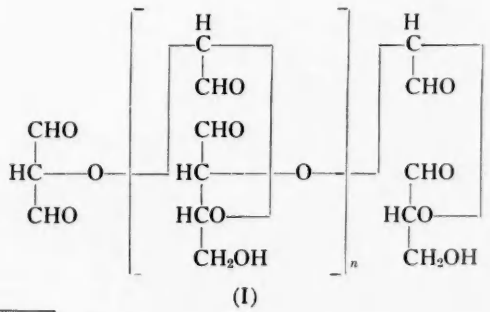
II. Estimation of Aldehyde Groups in Oxycellulose by the Hypoiodite Method

Eugene Pacsu

Contribution from the Textile Foundation and the Frick Chemical Laboratory at Princeton University

The various modifications of the aldehyde group determination by alkaline iodine solution were found to be unreliable for the aldehyde type of oxycellulose. The failure of the method is chiefly attributed to the instability of the oxidizing reagent, to certain prototropic and anionotropic conversions suffered by the oxycellulose in alkaline media, and to an iodoform-producing side-reaction of non-oxidative nature.

WHEN all the glucose units in cellulose are oxidized with sodium metaperiodate, theoretically the oxycellulose (I) should have the following structure:



(I)

In our experiments with such a "reducing" type of oxycellulose it frequently became necessary to analyze an aqueous solution for its oxycellulose content.

Romijn [1] discovered that aldoses under controlled conditions are oxidized by iodine in weakly alkaline solution to the corresponding monobasic acids, according to the equation (a):

$$R.CHO + I_2 + 3NaOH \rightarrow R.COONa + 2NaI + 2H_2O. \quad (a)$$

Since the time of this discovery numerous attempts have been made to establish the right experimental conditions for the correct estimation of the aldehyde groups in the simple sugars as well as in other car-

* This is the second paper in a series—"Cellulose Studies." The first appeared in the October, 1945, issue, page 354.

bohydrate materials. Recent publications by Martin, Smith, Whistler, and Harris [2], and by Rutherford, Minor, Martin, and Harris [3], deal with the estimation of aldehyde groups in hydrocelluloses and in the reducing type of oxidized celluloses, respectively. Their procedure has been adopted by Goldfinger, Mark, and Siggia [4] in connection with their work on the kinetics of oxidation of cellulose with periodic acid for the analysis of the aldehyde content of the oxidized samples.

Of the numerous reactions indicative of the presence of carbonyl groups the hypoiodite method is at present considered by many investigators to be the most suitable for quantitative estimation of aldehyde groups. Although the method as used by Bergmann and Machemer [5] was adversely criticized for several reasons [6], it appeared to us that either the procedures recommended by Harris and his coworkers [2, 3], or the process devised by Kline and Acree [7] as a modification of the procedure of Willstätter and Schudel [8] might prove to be usable for the quantitative determination of periodate oxycellulose in aqueous solution. Therefore, we undertook a comparative study of the hypoiodite methods of analysis for oxycellulose and in the present paper the results of our investigation are reported.

It will be seen that this method is unsuitable for the quantitative estimation of periodate oxycellulose.

This result, however, is not really surprising in view of our previous [9] conclusions concerning the chemical behavior of the reducing type of oxycellulose in alkali. It only confirms our contention that neither physical and analytical measurements nor preparative methods can be applied to the reducing type of oxycellulose in alkaline media because of the rapid and extensive degradation which the molecules of such oxycelluloses suffer in the presence of hydroxyl ions. Another cause for the failure of the hypoiodite method is found in the nature of the reagent itself, for two reasons. First—and this is generally recognized—the consumption of iodine proceeds indefinitely, overoxidation easily occurs, and therefore the reaction cannot be expressed by a stoichiometric equation. Second—and this, perhaps, is less widely known—sodium hypoiodite is a very unstable reagent, in that it changes rapidly to form sodium iodate, which is unable to oxidize aldehyde or alcohol groups in alkaline solution. The general picture, therefore, shows that the active reagent, the hypoiodite ion, is rapidly converted into the ineffective iodate ion, while the oxycellulose, through both anionotropic and prototropic transformations, suffers rapid rearrangements into acidic products with the consequent decrease of the number of aldehyde groups originally present in the oxycellulose. The third difficulty, overoxidation beyond the —CHO → —COOH stage, is the consequence of the insufficient selectivity of the hypoiodite reagent. The nature of this "overoxidation" has so far been unknown, with respect to the course it may take and to the substances it produces. In such circumstances it would be, indeed, most surprising if the hypoiodite method gave satisfactory results. Elimination of the use of alkaline media seems to be the prerequisite for a successful method of analysis for the aldehyde groups in the reducing type of oxycelluloses.

At the present time, we are engaged in the development of such a method, which will be the subject of a future communication.

A. The Instability of the Hypoiodite Ion

The postulated reaction for the hypoiodite formation is

$$I_2 + 2OH' \rightleftharpoons IO' + I' + H_2O. \qquad (b)$$

Depending upon the concentration, time, temperature, and electrolytes present, a greater or smaller part of the hypoiodite ions are changed into iodate and iodide ions:

$$3IO' \rightarrow IO_3' + 2I'. \qquad (c)$$

Under certain conditions iodine may react with alkali without the formation of any appreciable amount of hypoiodite:

$$3I_2 + 6OH' \rightarrow IO_3' + 5I' + 3H_2O. \qquad (d)$$

In such a case the solution, being practically devoid of the active oxidizing agent, is useless for the purpose of estimation of aldehyde groups. It may also happen that, on account of the rapid reaction (c), the hypoiodite content of the solution is exhausted before all the aldehyde groups become oxidized to carboxyl groups. Since both the efficient IO' and the inefficient IO_3' ions are recovered when the solu-

TABLE I. IO′ Content of Iodine Solutions in Alkaline Media, Determined by Potentiometric Titration with 0.1*N* Arsenite Solution

	Time (min.)	I_2 solution	Alkali	0.1*N* arsenite (cc.)	IO′ content (%)
(a)					
t=0°C	0	5 cc., 0.1*N*	7.5 cc., 0.1*N*	—	100.0
	3		NaOH	3.93	78.6
	4			3.61	72.2
	8			2.17	43.5
	12			1.69	33.8
	16			1.09	21.9
	30			0.81	16.3
	40			0.64	12.8
(b)					
t=0°C	0	5 cc., 0.05*N*	20 cc., Na_2CO_3—	—	100.0
	6		$NaHCO_3$ buffer;	1.75	70.0
	10		pH 10.6	1.42	57.1
	24			1.09	43.8
	40			0.99	39.6
	70			0.78	31.3
	120			0.54	21.7
	990			0.23	9.2
(c)					
t=25°C	0	20 cc., 0.03*N*	10 cc., 0.05*M*	—	100.0
	10		borax buffer;	5.91	98.6
	60		pH 9.2	5.60	93.4
	150			5.21	86.9
	360			4.39	73.3
	1,020			4.32	72.0

tion is acidified and titrated with standard thiosulfate,

$$IO' + I' + 2H^+ \rightarrow I_2 + H_2O \qquad (e)$$

$$IO_3' + 5I' + 6H^+ \rightarrow 3I_2 + 3H_2O \qquad (f)$$

$$I_2 + 2S_2O_3'' \rightarrow 2I' + S_4O_6 \qquad (g)$$

it is not possible to determine from the result of this titration the composition of the alkaline iodine solution employed for the oxidation of the aldehyde groups. The difference between the total iodine added and the excess iodine as found by the thiosulfate titration is a measure of the extent of the oxidation and *other iodine-consuming reactions* suffered by the oxycellulose in alkaline media. However, we found that adopting Cüppers' [10] method for hypobromite and hypochlorite estimation, by potentiometric titration of the alkaline IO′ — IO_3' mixture with standard arsenite solution, it was possible to determine the IO′ content of the solution. In accordance with the equation (h)

$$IO' + HAsO_2 + H_2O \rightarrow I' + H_3AsO_4 \qquad (h)$$

a sharp break in the titration curve indicated the end-point of the reaction. Since the various modifications of the hypoiodite method for aldehyde estimations require different OH′ ion concentrations, we determined the IO′ content of the oxidizing reagent under the three frequently used conditions: namely, (a) in 0.1*N* sodium hydroxide solution at 0°C, (b) in sodium carbonate-sodium bicarbonate solution at pH 10.6 and 0°C, and (c) in a 0.05 molar borax solution at pH 9.2 and 25°C. The results of the potentiometric titrations obtained by Mr. Paul Van Fossen, Fellow of the Textile Research Institute, are shown in Table I.

It is seen from the data that in dilute sodium hydroxide solution at 0°C the IO′ concentration of the oxidizing reagent decreases to one-half of the theoretical value (100 percent) in about 7 minutes, and in the sodium carbonate-sodium bicarbonate buffer solution in about 15 minutes. The IO′ ions, on the other hand, are reasonably stable in a borax solution of pH 9.2 at room temperature. However, the advantage of IO′ stability in borax solution is offset by the fact that the rate of oxidation of the aldehyde group becomes rather slow. Neither is the action of the IO′ ions at pH 9.2 selective enough to be restricted to the oxidation of the aldehyde groups only.

At room temperature, there was almost no IO′ ion present in a few minutes after the addition of the 0.1*N* alkali to the 0.1*N* iodine solution. In Table I the figures in the second column ("Time") represent the total time of the experiment—that is, the time (30 seconds) needed for the addition of the iodine solution to the alkali, and also the time (60 to 80 seconds) necessary for the titration with the arsenite solution.

B. Experiments with Hypoiodite in Dilute Sodium Hydroxide Solution

Romijn [1] found that in strongly alkaline solution the oxidation proceeded beyond the aldonic acid stage, and for this reason he recommended the use of a borax-iodine solution. In this alkaline medium, however, complete oxidation required about 18 hours at room temperature. Willstätter and Schudel [8] succeeded in reducing the time necessary for complete oxidation by applying a quantity of 0.1*N* sodium hydroxide solution, equivalent to about one and one-half times that of the iodine used. Kline and Acree [7] criticized this procedure on the ground

TABLE II. OXIDATION OF 5 CC. SAMPLES OF 0.1 MOLAR OXYCELLULOSE SOLUTION WITH ALKALINE HYPOIODITE

Experiment No.	0.1*N* I_2 (cc.)	0.1*N* NaOH (cc.)	Time of reaction (min.)	0.1*N* HCl (cc.)	0.1*N* I_2 consumed (cc.)	Oxycellulose content calc'd. from I_2 consumed (%)	0.1*N* NaOH consumed (cc.)	Oxycellulose content calc'd. from NaOH consumed (%)
(A) series, $t=25°$ C								
1	23.30	34.95	approx. 8	37.33	22.78	113.9	31.15	103.8
2	25.41	38.11	approx. 8	41.48	24.27	121.3	32.86	109.5
3[a]	6.34	9.30	approx. 3	12.44	2.71	13.5	3.81	12.7
$t=0°$ C								
4	25.41	38.11	15	31.11	18.41	92.0	25.50	85.0
5	22.23	33.10	15	36.29	17.22	86.1	23.63	78.8
6	22.23	33.10	30	36.29	19.17	95.8	26.43	88.1
7	22.42	36.42	45	36.96	18.88	94.4	26.93	89.7
(B) series, $t=0°$ C								
8	22.42	34.34	10	34.85	15.14	75.7	21.55	71.8
9	22.42	34.34	20	34.85	17.06	85.3	24.25	80.8
10	22.42	34.34	30	34.85	18.07	90.3	25.50	85.0
11	22.42	33.92	40	35.91	18.00	90.0	25.74	85.8
12	22.42	33.92	50	35.91	18.17	90.8	25.84	86.1
(C) series, $t=0°$ C								
13	30.58	45.89	10	48.58	16.42	82.1	23.54	78.4
14	30.58	45.89	20	48.58	18.95	94.7	27.02	90.0
15	30.58	45.89	30	48.58	19.40	97.0	27.73	92.4
16	30.58	45.89	40	48.58	19.66	98.3	28.13	93.7
17	30.58	45.89	50	48.58	19.46	97.3	28.03	93.4
(D) series, $t=0°$ C								
18	20.38	29.92	30	32.74	17.56	87.8	24.92	83.0
19	20.38	30.92	15[b]	32.74	16.03	80.1	22.82	76.0
20	20.38	30.92	35[c]	32.74	18.66	93.3	26.40	88.0

(a) Second treatment of sample used for experiment No. 2.
(b) Dropwise addition of alkali in 12 minutes.
(c) Dropwise addition of alkali in 32 minutes.

that the great excess of iodine (about 1.5 to 4 times the volume required for oxidation of the aldehyde group) usually causes overoxidation. They devised a procedure using a well-defined excess of both iodine and alkali, and adding these reagents alternately in several portions at room temperature.

The total reaction time required about 7 to 8 minutes.

A great advantage of this method lies in the fact that by use of standard acid solution for acidification a check on the iodine value can be obtained by titrating with standard alkali the free acid left after completing the iodine titration [11]. As shown by equation (a), for every two equivalents of iodine used, three equivalents of acid are produced. The ratio of volumes of alkali to iodine consumed in the experiment should then be 3:2, if the reaction is confined to the aldehyde group alone. Any deviation from this ratio indicates that the iodine was used for oxidation of secondary or primary alcohol groups without the production of carboxyl groups, or for some other type of reaction which is not of oxidative

TABLE III. Oxidation in 20 Minutes at 0°C of 5 cc. Samples of 0.1 Molar Oxycellulose Solution in Aged Hypoiodite Solutions

Experiment No.	0.1*N* I_2 (cc.)	0.1*N* NaOH (cc.)	Time of ageing (min.)	0.1*N* HCl (cc.)	0.1*N* I_2 consumed (cc.)	Oxycellulose content calc'd. from I_2 consumed (%)	0.1*N* NaOH consumed (cc.)	Oxycellulose content calc'd. from NaOH consumed (%)
21	20.38	30.92	10	32.74	4.60	23.0	6.16	20.5
22	20.38	30.92	15	32.74	3.90	19.5	5.26	17.5
23	20.38	30.92	30	32.74	2.60	13.0	3.37	11.2

character. Since Kline and Acree's process in general gives quite satisfactory results for the aldoses, we have attempted to apply it for the quantitative estimation of the aldehyde groups in periodate oxycellulose under various experimental conditions.

The oxycellulose was prepared as described in Part I [9] of this series and it was used in a 0.1 molar (16 grams per liter) solution. Theoretically, 5 cc. of the solution containing 0.080 g. of pure oxycellulose (I) with two aldehyde groups per oxidized glucose unit should consume four equivalents (20 cc. of 0.1*N*) of iodine, and six equivalents (30 cc. of 0.1*N*) of alkali.

In the first three experiments (Table II, (A) series) the procedure employed by Kline and Acree [7] was closely followed. To 5 cc. of the supposedly 0.1 molar oxycellulose solution, after dilution with some distilled water, there were added alternately, in four portions, quantities of 0.1*N* iodine and alkali solutions. These early experiments were conducted at room temperature and the times for the reaction (approximately 8 to 10 minutes) were not recorded in a precise manner. All of the other experiments were carried out at 0°C (with inside and outside cooling) and exact time measurements were made. In experiments Nos. 4 to 7 addition of the four portions of iodine and alkali was so regulated that the operation required 10 minutes. This period of time is included in the times recorded in column 4.

The reaction was terminated by addition to the solutions of measured quantities of standard hydrochloric acid.

The iodine consumed during the oxidation reaction was then determined by titration with standard thiosulfate of the excess of iodine in the acidic solution. These values are given in column 6. After addition of two drops of phenolphthalein indicator to the titrated solutions, the excess acid was titrated with 0.1*N* alkali. In column 8 of Table II the quantities of alkali consumed for the neutralization of the acids produced in the oxidation of oxycellulose are given in cubic centimeters. In experiments Nos. 8 to 20 the iodine was added in one portion to a mixture of oxycellulose solution and some crushed ice, then the alkali was introduced dropwise in 5 minutes, with the exception of experiments 19 and 20, in which the addition of alkali took 12 and 32 minutes, respectively. These periods of time are included in the reaction times given in column 4. For the (B) series experiments, a 12 percent excess of iodine was used, whereas for the (C) series of experiments the excess was 52.9 percent. In the (D) series the excess of iodine was only 0.2 percent of the theoretical value of 20 cc.

It is evident from the results of these experiments that the method as employed is unsuitable for the determination of the oxycellulose content of a solution.

Variations from 75.7 percent to 121.3 percent occur, depending upon slight changes in the experimental conditions. Overoxidation takes place to a large extent at room temperature and the final results depend upon the amounts of iodine employed. At 0°C the extent of overoxidation appears to be decreased.

An increase in the reaction time over a limit of 30 minutes has no noticeable effect on the final results because most of the IO′ ions, as anticipated from (a) in Table I, are transformed to iodate ions during that period of time; the oxidizing power of the solution becomes exhausted. It is also seen that the percentages of the oxycellulose content calculated from the alkali consumption do not agree with those found from the iodine consumption. In other words, the

TABLE IV. OXIDATION AT 0°C OF 2.5 CC. SAMPLES OF 0.1125 MOLAR OXYCELLULOSE SOLUTION AT pH 10.6

Experiment No.	Na_2CO_3—$NaHCO_3$ buffer sol. (%)	0.1N I_2 (cc.)	Time of reaction (hrs.)	5N HCl (cc.)	0.1N I_2 consumed (cc.)	Oxycellulose content (%)
24	360	45.0	1	36.0	17.6	78.2
25	360	45.0	3	36.0	20.9	92.6
26	360	45.0	5	36.0	22.5	100.0
27	360	45.0	8	36.0	25.4	113.1

ratio of volumes of alkali to iodine is not 3:2 as required by the stoichiometric equation (a). The fairly large departure from this ratio strongly suggests that either groups other than aldehyde are oxidized during the reaction or the iodine is consumed in a side-reaction which is not of oxidative character. Evidence in favor of the latter was found in the formation of considerable quantities of iodoform in all of the experiments presented in this paper.

The significance of this important fact will be discussed later in this paper.

Further variations in the experimental conditions were introduced to ascertain the importance of the time element in the oxidation reaction with respect to the instability of the IO′ ion. In Table III are summarized the results of experiments in which mixtures of iodine and alkali solutions were first kept for a specified time (column 4) at 0°C before the oxycellulose solution was introduced. The reaction mixtures were then kept at 0°C for 20 minutes before acidification. The rapid and complete disappearance of the color of the hypoiodite solution shortly after the addition of the oxycellulose strongly indicated that very little hypoiodite remained in the iodine-alkali mixture after it had stood at 0°C for the specified times.

It is seen from these results that the concentration of the hypoiodite ions available for the oxidation reaction is decreased to less than one-fourth of the theoretical in 10 minutes, and to about one-eighth of the theoretical in 30 minutes. It is noteworthy that even under such conditions part of the iodine is apparently used for overoxidation or for side-reactions, since the oxycellulose values (column 9) calculated from the alkali consumption are lower than those (column 7) obtained from the iodine consumption on the basis of the theoretical ratio of 3:2.

C. Experiments with Hypoiodite in Sodium Carbonate-Sodium Bicarbonate Buffer Solution at pH 10.6

In order to avoid overoxidation which he found to have occurred with caustic alkali, Romijn [1] employed buffer salts, such as sodium carbonate, sodium bicarbonate, borax, etc., to supply the necessary alkalinity. Auerbach and Bodländer [12] used a mixture of equal portions of 0.2 M sodium carbonate and bicarbonate solutions with pH 10.2 and a reaction time of 1½ to 2 hours. Martin, Smith, Whistler, and Harris [2] recommended the use of a buffer solution at about pH 10.6 prepared by mixing 15 parts of 0.2 M sodium carbonate and 1 part of 0.2 M sodium bicarbonate solutions. These authors conducted their experiments on a series of hydrocellulose samples at 0°C and compared the results of the

TABLE V. OXIDATION IN 2 HOURS AT 0°C OF 5 CC. SAMPLES OF 0.1 MOLAR OXYCELLULOSE IN AGED HYPOIODITE SOLUTIONS AT pH 10.6

Experiment No.	0.1N I_2 (cc.)	Na_2CO_3—$NaHCO_3$ buffer sol. (cc.)	Time of ageing (hrs.)	5N HCl (cc.)	0.1N I_2 consumed (cc.)	Oxycellulose content (%)
24	42.35	320	0.0	32.0	15.77	78.8
25	42.35	320	1.5	32.0	6.21	31.0
26	42.35	320	17.0	32.0	1.54	7.7

TABLE VI. OXIDATION WITH HYPOIODITE IN 2 HOURS AT 0°C OF 5 CC. SAMPLES OF 0.1 MOLAR OXYCELLULOSE SOLUTION AGED IN BUFFER SOLUTION AT PH 10.6

Experiment No.	Na_2CO_3—$NaHCO_3$ buffer sol. (cc.)	Time of standing in buffer sol. (hrs.)	0.1N I_2 (cc.)	5N HCl (cc.)	0.1N I_2 consumed (cc.)	Oxycellulose content (%)
27	320	0.5	42.35	32.0	21.17	105.8
28	320	2.5	42.35	32.0	24.50	122.5
29	320	4.5	42.35	32.0	24.28	121.4
30	320	16.0	42.35	32.0	14.73	73.6

analyses after a reaction time of 3 hours. By employing this method for oxycellulose solutions we obtained the following results, which are summarized in Table IV.

The continuous increase in the iodine values clearly shows that the consumption of iodine does not cease at any given time but proceeds indefinitely. Precipitation of iodoform always occurred and this fact also proves that the reaction is not stoichiometric.

Another disadvantage of this method is due to the rapidly decreasing IO′ concentration during the oxidation reaction. According to the data on the instability of the hypoiodite ion in the sodium carbonate-sodium bicarbonate buffer solution (Table I, (b)), at the end of 3 hours the concentration of the IO′ ions, on account of their transformation into the ineffective iodate ions, decreases to about 15 percent of the initial concentration. The effect of this behavior of the IO′ ion clearly shows in the results of our experiments (Table V), which were also conducted by following the essential details of the above authors' [2] procedure with the exceptions that the oxycellulose samples were added to aged hypoiodite solutions and that the time of oxidation was reduced to 2 hours.

The rapidly decreasing values of the consumed iodine (column 6) suggest that the long period of time (2 to 3 hours) required for the oxidation of the aldehyde group at pH 10.6 may render the results of analyses for aldehydes in samples of unknown oxycellulose content quite useless. This can be avoided only if a large initial excess of iodine is employed, but in such case the danger of overoxidation is considerably increased.

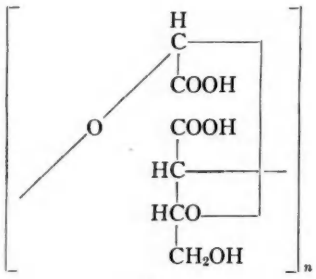
Still another important factor to be considered is the destructive effect of alkalinity on oxycellulose. During the prolonged oxidation reaction by IO′ the unattacked portions of oxycellulose suffer prototropic and anionotropic changes with the primary production of glycolic acid, erythrose, and other substances, as was discussed in Part I [9] of this series. The degradation products, which form at a rapid rate, give rise—at least in the early stages of the reaction—to substances which react with considerable amounts of iodine. This is evident from the fact that in these experiments the iodoform formation was heavier than in the other experiments.

The predictable effect of alkali on oxycellulose with the resulting high iodine consumption in the early stages of the reaction is seen from the data in Table VI.

TABLE VII. OXIDATION AT 0°C AND AT PH 10.6 OF 3.4 CC. SAMPLES OF BROMINE-OXIDIZED OXYCELLULOSE PREPARED FROM A 2.7% OXYCELLULOSE SOLUTION

Experiment No.	Na_2CO_3—$NaHCO_3$ buffer sol. (cc.)	0.1N I_2 (cc.)	Time of reaction (hrs.)	5N HCl (cc.)	0.1N I_2 consumed (cc.)	Oxycellulose content (%)
31	360	45.0	1	36.0	2.70	11.7
32	360	45.0	3	36.0	3.05	13.3
33	360	45.0	5	36.0	3.45	15.0
34	360	45.0	18	36.0	5.75	25.0

In connection with the problem of overoxidation it was desirable to obtain information as to the effect of IO′ on an oxycellulose in which the aldehyde groups had already been oxidized. A stock solution was prepared by treating a 2.7 percent oxycellulose solution with bromine in the presence of a slight excess of sodium bicarbonate. Although the aerated solution was devoid of action toward Fehling solution, thus proving the absence of reducing groups in the substance (II),



(II)

it used up, as shown in Table VII, considerable amounts of iodine.

In the last column the figures were calculated from the iodine consumption on the basis of the 0.0918 g. of oxycellulose originally present in a 3.4 cc. sample.

The nature of the reaction is not known at present, but the formation of comparatively large amounts of iodoform suggests that the reaction is not essentially of oxidative character.

D. Experiments with Hypoiodite in Sodium Tetraborate Buffer Solution at pH 9.2

Romijn [1] introduced the use of borax solution in the estimation for aldehyde groups with iodine. He found that at room temperature it took 18 to 22 hours to complete the reaction and that some overoxidation occurred. Rutherford, Minor, Martin, and Harris [3] employed 0.05 molar sodium borate solution having a pH of 9.2 at 25°C for the oxidation of the aldehyde groups in cellulose samples which were slightly oxidized with periodic acid. They carried out the reactions at room temperature and

TABLE VIII. OXIDATION AT 25°C OF 5 CC. SAMPLES OF 0.1 MOLAR OXYCELLULOSE IN 10 CC. OF 0.05 MOLAR SODIUM BORATE SOLUTION OF PH 9.2

Experiment No.	0.03N I_2 (cc.)	Time of reaction (hrs.)	0.1N I_2 consumed (cc.)	Oxycellulose content (%)
35	20.39	1	1.13	56.8
36	20.39	2	1.41	70.8
37	20.39	4	1.58	79.0
38	20.39	5	1.68	84.0
39	20.39	6	1.76	88.0
40	20.39	7	1.80	90.1
41	20.39	18	2.08	104.2
42	20.39	29	2.20	110.2

terminated the oxidation by addition of hydrochloric acid after 6 hours. Goldfinger, Mark, and Siggia [4] used a boric acid-sodium tetraborate buffer (50 g. boric acid—50 g. borax per liter solution) of a pH about 8, decreased the time to 3 hours, and conducted the reactions at 0°C. Since we have found that under such experimental conditions not even glucose can be oxidized to any extent whatsoever, we adopted the procedure of Rutherford, Minor, Martin, and Harris [3] for our experiments, the results of which are presented in Table VIII. In these experiments, just as in those summarized in Tables II and IV, the continuous rise in the iodine consumption shows that the reaction does not cease at any given time.

This, of course, makes the method worthless for quantitative estimation of the oxycellulose. In one special experiment prolonged standing (16 hours) of the oxycellulose in the buffer solution before the addition of iodine had a profound effect in that then the iodine consumption in a 6-hour reaction period indicated the presence of 106 percent oxycellulose against the 88 percent found in experiment No. 39, in which the oxycellulose was immediately added to the buffer-iodine mixture. On the other hand, the use of a 17-hour-old iodine-buffer solution decreased only to 50 and 74 percent the oxycellulose values during the oxidation times of 1 and 4 hours, respectively. In experiments Nos. 35 and 37, where the oxycellulose was immediately introduced in the buffer-iodine mixture, these values were found to be 56.8 and 79 percent, respectively. The smaller effect

of an aged hypoiodite-borate buffer solution on the oxidation reaction was to be anticipated from the increased stability of the IO′ ions at low alkalinity (Table I, (c)).

E. Formation of Iodoform from Periodate Oxycellulose and Oxystarch

The observed precipitation of iodoform during the oxidation reaction of periodate oxycellulose with hypoiodite represents a most interesting problem which deserves special investigation. Since the chemical structure of periodate oxystarch does not essentially differ from that of oxycellulose it was not surprising to find that periodate oxidized wheat, potato, and corn starch also yielded considerable quantities of iodoform with hypoiodite. On the assumption that one mole of iodoform will form from every oxidized glucose unit, the amounts of iodoform actually isolated were found to be 4 to 6 percent of the calculated values.

Iodoform can be obtained only from compounds which contain the grouping CH_3—CO— when joined to a hydrogen atom or to a carbon atom which does not carry active hydrogen atoms. It will, of course, be given also by any compounds which react with the reagents, alkali and iodine, to give a derivative containing the requisite grouping. Since oxycellulose and oxystarch do not contain the CH_3—CO— grouping, evidently the latter must be formed subsequently from the oxidized glucose units on the interaction of the alkaline hypoiodite solution. If this conclusion were correct, then one would expect that erythronolactone also would give iodoform. We found that this, indeed, is the case; we isolated 2 percent iodoform from *D*-erythronolactone and sodium hypoiodite.

The formation of iodoform would explain the "overoxidation" which was observed in all of our experiments.

As shown by equation (i) for the iodoform formation,

$$\begin{aligned} &\mathrm{CH_3{-}\overset{\overset{\mathrm{O}}{\|}}{C}{-}R + 3I_2 + 4NaOH \rightarrow} \\ &\mathrm{CHI_3 + R{-}\overset{\overset{\mathrm{O}}{\|}}{C}{-}ONa + 3NaI + 3H_2O,} \quad \text{(i)} \end{aligned}$$

for every six equivalents of iodine used four equivalents of acid are produced. The ratio of volumes of alkali to iodine is, therefore, 2:3, which is just the reverse of the ratio in the oxidation of the aldehyde groups (equation (a)). It is probable that the difference between the oxycellulose contents calculated from the iodine and from the alkali consumptions (Tables II and III) is, at least in part, a measure of the extent of the side-reaction of iodoform formation.

On account of its importance and implications the iodoform formation from oxycellulose, oxystarch, and certain lactones, as well as its mechanism, will be the subject of a future communication.

Summary

The quantitative estimation of the aldehyde groups in periodate oxycellulose by means of alkaline iodine solutions was investigated under various experimental conditions.

The instability of the oxidizing reagent was demonstrated by potentiometric titration for IO′ ion with standard arsenite solution. It was found that the IO′ concentration in dilute alkali at 0°C decreased to one-half of the theoretical value in about 7 minutes and in a sodium carbonate-sodium bicarbonate buffer solution at pH 10.6 and at 0°C in about 15 minutes. In a borax buffer solution at pH 9.2 and at room temperature 73.3 percent of the IO′ ions were still present after 6 hours' standing.

In the estimations for oxycellulose contents by Kline and Acree's method variations from 75.7 percent to 121.3 percent were obtained, depending upon slight changes in the procedure.

Similar inconsistent values were found when Harris and his coworkers' procedures were followed, both in sodium carbonate-sodium bicarbonate buffer solution at pH 10.6 and 0°C and in borax buffer solution at pH 9.2 and 25°C.

Variations in the oxycellulose values were also found, depending upon the age of the hypoiodite solutions and on the time of standing of the oxycellulose in the alkaline solutions employed in the oxidation reaction.

Quantitative data indicating the extent of "overoxidation" were obtained in the experiments conducted in dilute iodine-alkali mixtures.

The probable nature of at least part of this "overoxidation" is discussed in connection with the sig-

nificant observation of iodoform formation in all of these experiments.

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Measurement of Cotton Fiber Strength by the Flat Taped Bundle Method*

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The flat taped bundle test as applied to the measurement of the strength of cotton fibers has been modified during the course of several years. The method has proved satisfactory for both routine and research purposes. The techniques and apparatus are described in detail. Some causes of error and factors other than the fiber strength which introduce variations in test results have been investigated and are discussed. The effects of varying bundle width and weight, direction of fibers, jaw pressure and separation, humidity, and type of tape used have been studied. The observed precision of test results and their statistical reliability are presented. A calibration method is described which greatly reduces the effects of several operators.

THE increasingly widespread application of fiber tests by breeders and users of cotton endows the subject of fiber strength measurement with considerable practical significance.

Fibers may be measured singly or in bundles. The techniques for measuring the strength of single fibers have been thoroughly covered by several writers [1, 2, 3]. Three techniques have been developed using bundles of fibers. These are the round wrapped, or modified Chandler bundle [4, 5], the flat untaped bundle developed by Pressley [6], and the flat taped bundle [7, 8, 9, 10].

This paper deals with the flat taped bundle method of measuring fiber strength as applied to cotton. The method is not widely used in this application although it is specified as a standard strength test for staple rayon fibers by the A.S.T.M. Committee D-13 [10]. However, the method has proved satisfactory in this laboratory for both routine and research purposes. During the time that it has been used, many experiments have been made to appraise it.

The work reported here does not represent an exhaustive exploration of the method, but it has been sufficient to indicate the apparent relative influence of some of the variables on the strength of the fibers. The indicated trends become of increased interest when compared with corresponding phases of the Pressley test as described recently by Williams and Painter in this JOURNAL [11].

Although the method used at the Kendall Mills Laboratories conforms in general with the methods reported by others [7, 8, 9, 10], there have developed enough differences in technique to make a description of the test desirable. A feature of the method is the use of a reference cotton to which all test results are related. By this means results obtained by different operators are in effect calibrated, and differences between them are eliminated.

Description of the Flat Taped Bundle Fiber Strength Test

Samples of cotton weighing 2 to 4 ounces are spread out in a conditioning room (70°F, 65 percent R.H.) and allowed to remain at least 8 hours. Eight to 10 tufts of fibers are then taken at random from each sample. The tufts from each sample are of such a size that when combined they can be held easily in the hand. This is roughly 3½ grams of cotton. One strength measurement is made on each group of combined tufts from each sample. Several samples are prepared from each lot of cotton to be tested.

Each group of combined tufts is "broken" between the hands, as in the hand stapling of cotton. The two halves are recombined and held in one hand so that the planes across which the break occurred

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are together and exposed. Again as a classer makes his pull, the neps and tangles of fibers of this exposed, broken face are worked out with the fingers. Finally, 30 to 40 milligrams of fibers are drawn endwise from the handful. These are grasped firmly between the thumb and first finger along a line approximately 3/8 inch from the mid-point of the fibers. While held in this position the fibers are drawn through a comb fifteen times. This combing removes all remaining neps, tangled fibers, and all fibers which are not firmly held between thumb and finger.

In the first strokes only the ends of the fibers are combed. As the ends are straightened, in the succeeding strokes progressively more of the exposed fiber length is combed, until in the last few of the standard fifteen passes the entire exposed length of the fibers is combed. This procedure prevents excessive fiber breakage or damage, which is important if reliable values of strength are to be obtained.

The comb is shown at C in Figure 1. It is rigidly mounted on the table top at a slight angle, to facilitate the combing operation. The comb is 4 inches long and has teeth 3/16 inch in length, which are spaced 56 to the inch.

At the completion of fifteen passes through the comb, the fibers are grasped in the operator's other hand on a line 3/4 inch from the line on which they were originally held. The combing process is repeated with the fibers held in this position, until an additional fifteen passes have been made. This combing removes all fibers shorter than about 3/4 inch in length.

After combing, the fibers are carefully laid on a glass plate, shown at P in Figure 1. A template, T, mounted on a hinge, is pressed onto the fibers, holding them firmly. This template is 0.75 inch wide and 2 inches long. The fibers, shown at F, are placed perpendicular to the long edge of the template and with their mid-section in a position to be covered by the template. That portion of the fibers which extends out from either side of the template is cut off with a single stroke of a glass cutter.

The template is next lifted from the fibers, which now form a thin, uniform, paralleled group, all 0.76 inch in length. The cut fibers are longer than the width of the template because of the thickness of the cutting wheel of the glass cutter. The weight of this group should be about 10 milligrams. The fibers on the edge are usually slightly disarrayed and are removed without disturbing the others. Enough

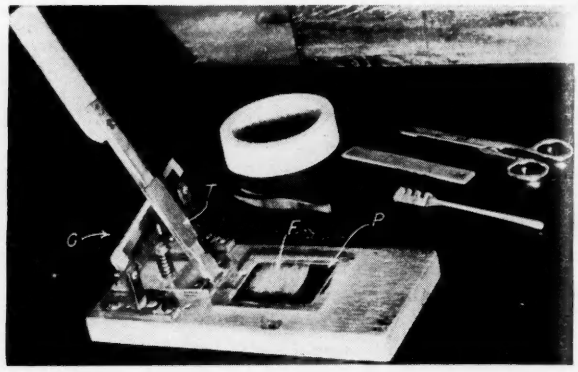

FIG. 1. *Equipment used in preparing flat taped bundles. The template is shown in the raised position and the fibers are in place on the glass plate.*

fibers are removed so that the bundle weighs between 7 and 8 milligrams. The weight of the remaining bundle is estimated.

When an estimated 7 to 8 milligrams of fibers remain, the bundle is carefully folded and weighed on a torsion balance to the nearest one-hundredth of a milligram. If its weight is actually between 7 and 8 milligrams, it is satisfactory. If it weighs more than 8 milligrams, fibers are carefully removed until on reweighing it does fall within this limit. On the other hand, if the bundle weighs less than 7 milligrams, it is discarded and the preparation of the bundle is started again from the beginning.

When the weight of the bundle is in the desired range, it is placed on a smooth board painted dull black. The fibers are manipulated so that they form a group of even thickness, 3/4 inch wide (Figure 2, step 1). The width of the bundle is gaged by comparing it to two lines on the board which are 3/4 inch apart. While it is in this position a 2 1/2-inch length of 1-inch Scotch drafting tape is placed, sticky side down, on the fibers so that one-half of their length is covered (step 2). The tape, with the fibers adhering to it, is then pulled from the board. The tape is next folded midway of its length with the sticky side in, and pressed firmly together. At this stage, the bundle of fibers is held by the tape on both sides along half the length of the fibers. Care should be taken to match the edges of the top and bottom tapes. The double tape is now cut to a length of 1 inch, leaving 1/8 inch on each side of the bundle of fibers (step 3).

A second tape is applied to the exposed half of the fibers, following the procedure for the first (steps

4 and 5). A gap 1/64 inch wide is left between the adjacent edges of the two tapes.

The taped bundle is numbered for identification and another is prepared. Usually all bundles are prepared before any are tested for strength. The bundles are broken on a standard commercial pendulum-type strength testing machine. The machine used has a capacity of 25 pounds, graduated in tenths of a pound. The jaw faces, front and back, are 1 inch by 2 inches. The machine has been slightly modified so that the distance between jaws is set at 3/64 inch. This has been done by adding an extension to the support of the lower jaw, in such a way that when the top jaw is in the starting position it rests on the bottom jaw. The spacing is accomplished by shims of the proper thickness which are permanently attached to the jaws. Each jaw grasps one tape, leaving the open gap between the tapes midway between the jaws.

The breaking strength in pounds is divided by the weight of the fibers in milligrams and multiplied by ten.

This value is the strength of the cotton expressed as pounds per 10 milligrams of fibers 0.76 inch long. The computation is carried to four figures, rounded off to three, and entered on a data sheet.

All bundle strengths from one lot are averaged and then adjusted according to the reference cotton, as described in the next section.

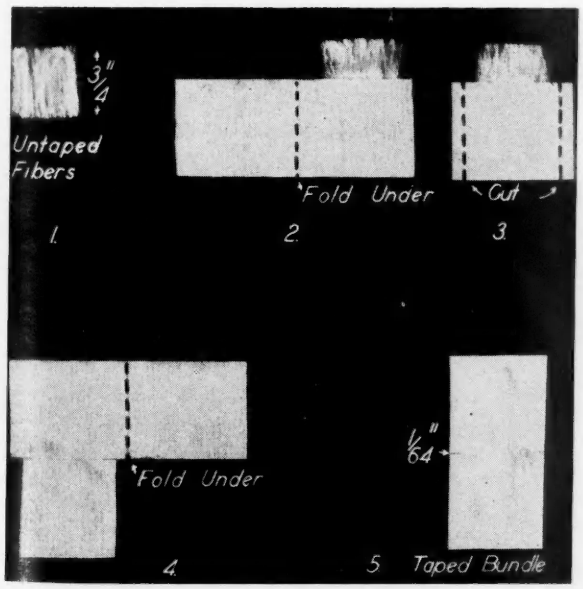

FIG. 2. *Steps in the taping of a flat bundle.*

Reference Cotton

It is desirable to have a standard with which test results may be compared. The most satisfactory standard that has been found consists of a large, well-mixed lot of cotton in the form of a picker lap. This picker lap, which is called the "standard picker lap," has been used since early 1939. It has been kept at standard conditions of temperature and humidity during most of the time that it has been in use.

It has been assumed that the true strength of this standard picker lap has remained constant. Although this cannot be definitely proved, there is reason to believe that this is so. The strength of the standard picker lap has varied in a random, rather than a systematic, manner, and, except for variations due to change of operators, yearly averages of strength have not changed significantly.

It does not matter what this strength is for comparative purposes, as long as it remains constant. For our purpose it has been set at 25 pounds per 10 milligrams of cut fibers.* This is close to the long-time average strength as measured by several operators.

Although it has been assumed that the standard picker lap has a constant strength, different operators obtain different average breaking strengths for it. It has also been noted that changes in technique, inadvertent or otherwise, affect the picker lap average. The strength of the standard picker lap is determined each day. The resulting data serve incidentally as a check or control on the technique, but, more immediately, to "calibrate" the operator.

A four-day moving average is calculated from the daily breaks made with the standard picker lap. The average used each day includes the breaking strength measured that day and those recorded on the three previous days. A moving average is used in order to include sufficient data to give a low standard error, and to avoid excessive unproductive testing.

If the four-day moving average for the standard picker lap is other than 25 pounds per 10 milligrams —say it is $S_{p.l.}$—then all other breaking strengths

* It could have been set at any other value—say, 10 or 100. Were this done, the adjusted "strength" would properly be termed an "index." The advantage of using approximately the actual average strength is that the adjusted values can then be expressed in other terms without use of a constant peculiar to the selected reference value of strength.

TABLE I. EFFECT OF ADJUSTING THE OBSERVED BUNDLE STRENGTH WITH REFERENCE TO THE STANDARD PICKER LAP COTTON

Cotton	Test	No. Breaks	Picker lap moving average (lbs./10 mg.)	Average observed strength (lbs./10 mg.)	Average adjusted strength (lbs./10 mg.)
A	1	6	23.4	23.9	25.6
	2	6	23.7	24.0	25.2
	3	6	23.3	23.4	25.1
	4	6	23.9	23.4	24.5
	Range			0.6	1.1
B	1	6	23.4	25.3	27.0
	2	6	23.7	25.7	27.0
	3	6	23.3	24.6	26.4
	4	6	23.9	26.1	27.3
	Range			1.5	0.9
C	1	6	23.4	24.9	26.6
	2	6	23.7	25.0	26.3
	3	6	23.3	25.4	27.2
	4	6	23.9	25.7	26.9
	Range			0.8	0.9

obtained that day by that operator are adjusted by multiplying the observed machine break, expressed in pounds per 10 milligrams, by the factor

$$\frac{25}{S_{\text{p.l.}}}.$$

Thus the adjusted value of strength for any cotton is

$$S \text{ adjusted} = \frac{25}{S_{\text{p.l.}}} S,$$

where S is the strength of the cotton as recorded on the breaking machine, expressed in pounds per 10 milligrams.

Although this adjustment reduces variations due to causes which affect all breaks alike—as, for example, faulty testing equipment—at the same time it introduces the variability of the daily picker lap measurements. This effect on the adjusted strength is illustrated in Table I, in which actual and adjusted strengths of three cottons are shown for a series of four tests over a period of two months. It is seen that the range of adjusted strengths for two of the cottons is greater than before the adjustment. The loss in precision, however, is not great. This loss may be considered the cost of insurance to avoid gross variations. It is of greater significance, however, that adjustment of all breaking strengths in terms of a standard eliminates, in effect, differences between operators. This aspect of the adjustment of strengths will be discussed below.

Precision of the Flat Taped Bundle Method

Two general sources of variation are present when bundle strength measurements are made: those due to the technique and those which result from sampling.

An estimate of the variation arising from the first source can be made from repeated tests on a single homogeneous cotton. This has been done, and it has been found that the breaks made by an experienced operator exhibit coefficients of variation which generally fall in the range from 1 percent to 3 percent.

Although the standard picker lap is not as homogeneous as a sample can be made, the data illustrate how the coefficient of variation may be expected to behave. The daily averages of the picker lap breaks and the associated coefficients of variation for a typical month are shown in Table II. The average coefficient of variation computed from the daily averages is 2.2 percent for this month. The range of these coefficients is from 0.7 to 3.4 percent.

Bellinson [9] reports data on similar flat taped bundles, showing a range in the coefficient of variation from 0.75 to 2.31 percent. Grimes [8] has reported an average coefficient of 5.8 percent. Williams and Painter [11] show data which indicate that the coefficient of variation of the Pressley test, which measures a flat but untaped bundle, may range from 2.9 to 6.9 percent.

When testing a less homogeneous source of cotton, such as bale samples from one locality, the coefficient of variation has been observed to range normally from 3 to 5 percent. The inhomogeneity of the bale samples may be assumed to be responsible for this increased value of the coefficient.

If it is assumed that an average value for the co-

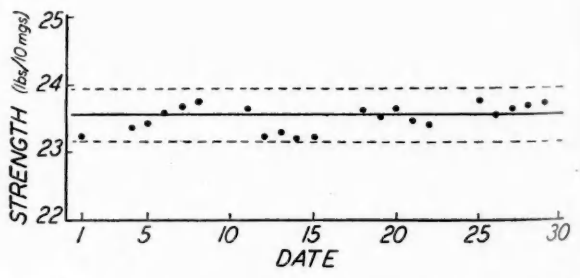

FIG. 3. *A typical portion of the control chart of the moving average for the reference cotton.*

TABLE II. Daily Strength Record—Standard Picker Lap (September, 1944)

Date	Average strength* (lbs./10 mg.)	Coefficient of variation (%)
8/ 1/44	22.9	2.0
8/ 4/44	23.6	1.8
8/ 5/44	23.9	1.7
8/ 6/44	24.1	2.4
8/ 7/44	23.0	1.3
8/ 8/44	23.9	3.4
8/11/44	23.6	1.9
8/12/44	23.4	2.4
8/13/44	23.2	0.7
8/14/44	23.6	3.0
8/15/44	23.6	0.7
8/18/44	24.0	3.2
8/19/44	22.8	2.7
8/20/44	24.2	2.6
8/21/44	23.0	2.4
8/22/44	23.8	2.1
8/25/44	24.1	2.2
8/26/44	23.4	3.4
8/27/44	23.3	1.1
8/28/44	24.2	2.2
8/29/44	24.2	2.7
Average	23.6	2.2

* Average of four breaks.

efficient of variation for a lot of cotton is 5 percent, then the standard deviation for a cotton whose mean strength is 25 pounds per 10 milligrams would be $\pm$ 1.2 pounds per 10 milligrams. If nine measurements were made and averaged, the standard error of the mean would be $\pm$ 0.4 pound per 10 milligrams; the standard error for sixteen measurements would be $\pm$ 0.3 pound per 10 milligrams. This means that for two lots on each of which nine measurements are made a difference of about 1.2 pounds per 10 milligrams or greater must be observed to consider the lot means significantly different at the 5 percent level of confidence. If sixteen measurements were made on each lot, a difference in mean strength of 0.9 pound per 10 milligrams or greater would be considered significant at the same confidence level. However, the above values, although typical in the majority of cases, can be taken only as guide posts. In practice, the significance of an observed difference between two lots of cotton must be appraised from the actual data.

The precision of the four-day moving average for the standard picker lap is represented by the value of its standard error, which is approximately $\pm$ 0.12 pound per 10 milligrams. A "control chart" on the standard picker lap breaks may be kept. Such a chart has the long-time average strength characteristic of the operator as its central line, and control limits at $\pm$ 0.4 pound per 10 milligrams about this mean [12]. A typical portion of such a chart is shown in Figure 3. Each point on the chart is a four-day average representing 16 breaks. The usual criteria for action are followed. The action required is an examination of the testing apparatus, the operator's technique, and an appraisal of the picker lap standard itself.

Dependence of Strength on Factors other than the Fibers

As has been stated, the observed breaking strength of fibers is affected by several factors other than the actual strength of the fibers themselves. A discussion of some of these factors follows:

Effect of Tape

The flat taped bundle uses, in effect, a new jaw surface for each break. In order that successive breaks may be compared, it is necessary that each new jaw surface be like the preceding one. In practice, this condition is not entirely met. There are variations from lot to lot of the tape used, from roll to roll, and even within one roll. It has been impossible to eliminate these variations with the tapes which are available.

Since the influence of the tape cannot be avoided, a technique is followed which is intended to randomize its effect. This is to use different rolls of tape for consecutive breaks. At the present time five rolls are always in use. The first bundle is made with tape from rolls 1 and 2, the second from rolls 3 and 4, the third from rolls 5 and 1, etc. The rolls have been put into use in such a manner that when roll 1 is new, roll 5 is nearly empty, and rolls 2, 3, and 4 are in successive stages of being used.

In a study of various tapes, preliminary tests indicated that regular commercially available adhesive tape produced a lower coefficient of variation of bundle strength than two laboratory-prepared tapes or a commercial tire tape. The adhesive tape was easier to handle than the other tapes. Transparent cellulose tape could not be satisfactorily manipulated; therefore no tests were made with it.

Subsequent tests showed that bundles made with adhesive tape have a significantly higher strength and a greater coefficient of variation than those made with

drafting tape. Since the magnitude of the observed fiber strength has been considered in a relative rather than an absolute sense, a moderate loss in strength resulting from the choice of tape is of less importance than a reduction in the coefficient of variation. Thus, on the basis of the test results and of the observation that drafting tape is easier to handle than adhesive tape, the standard tape for strength breaks made in this laboratory was changed to Scotch-type drafting tape.

Further tests revealed no significant differences between different rolls of drafting tape as judged by normal variations within the rolls at the 5 percent level of confidence.

Because of war restrictions, the manufacture of the old Scotch tape was discontinued. A substitute was offered. Although both the paper backing and the formula for the adhesive had been changed in this substitute tape, parallel tests on the regular and substitute tapes indicated that they give the same results when used in the flat taped bundle test.

Effect of Bundle Weight

It is the practice at the Kendall Mills Laboratory to make bundles weighing between 7 and 8 milligrams. However, breaking strengths are compared by expressing them as a bundle weighing 10 milligrams. The conversion is made by simple proportion, since it has been found that, within limits, bundle strengths are directly proportional to bundle weights.

This linear dependence of bundle strength on weight was shown by preparing bundles from the standard picker lap. These were allowed to range in weight from 3 to 16 milligrams. The plot of the breaking strength and the weight of the bundles is shown in Figure 4. It is seen that the points determine a straight line in the range from 3 to 10.9 milligrams. Above 10.9 milligrams the plot departs from linearity.

The coefficient of correlation of breaking strength and bundle weight for the bundles weighing less than 10.9 milligrams was found to be 0.992, the standard error of estimate of fiber strength was 0.69 pound. In the regression equation for the points,

$$Y - 2.23X = 0.12,$$

Y is the fiber strength expressed in pounds, and X is the bundle weight in milligrams. These results agree with those found earlier by Bellinson [9].

Although there appears to be almost a straight-line relationship between bundle weight and strength, it has proved desirable to limit the weight of the bundle to the range from 7 to 8 milligrams. For a bundle weighing over 8 milligrams the capacity of the testing machine will be exceeded for strong cottons. For bundles under 7 milligrams, the errors due to inherent inaccuracies of the machine when the lower portion of the scale is used are greater than if the breaks occur in the middle of the scale.

Effect of Humidity

To determine the approximate dependence of breaking strength on relative humidity, samples were drawn from a homogeneous lot of cotton and eight bundles were broken after being conditioned at each of three different humidities, the temperature being held constant. The relative humidities at which the samples were conditioned and broken were 55, 67, and 74 percent R.H. The conditioning room was held within a range of ± 2 percent R.H. during these measurements, and within $\pm 1°$F of the standard temperature of 70°F.

It was found that the breaking strength of the fibers increased approximately 0.09 pound per 10 milligrams for each 1 percent increase in relative hu-

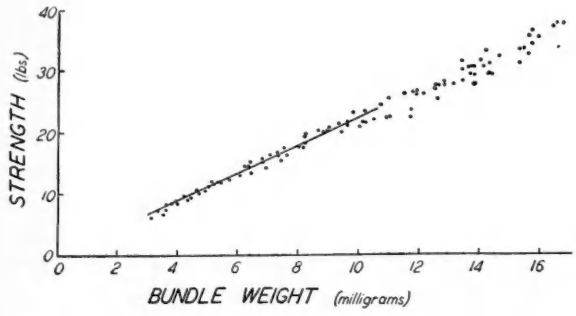

FIG. 4. *Effect of bundle weight on observed strength. The regression line for bundles weighing less than 10.9 milligrams is shown.*

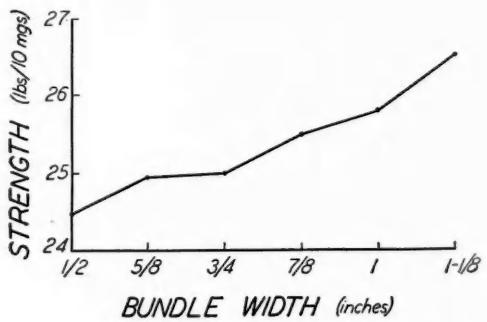

FIG. 5. *Effect of bundle width on observed strength.*

midity between the extremes of 55 and 74 percent R.H.

No consideration has been given to the possible effects, if present, of a hysteresis in the humidity-strength relationship nor to the effect of different cottons. The observed value of 0.09 pound per 10 milligrams for each 1 percent change in relative humidity has been thought to indicate that such variations in relative humidity as generally occur in a conditioned room probably produce negligible variations in the observed bundle strengths.

Effect of Bundle Geometry

The standard width to which the combed and cut fibers are arrayed before being taped is ¾ inch. To learn the effect of increasing the width of the array of fibers, 18 bundles 1⅛ inches wide were prepared and their strengths compared with those of 18 bundles of standard width. All bundles were prepared from the same cotton. The experiment showed that the wider bundles were significantly stronger than the standard bundles. The average increase in strength was 0.17 pound per 10 milligrams for each 1/16-inch increase in width for these two widths.

This experiment was later repeated by different operators, using different cotton. Two operators each prepared 30 bundles, 5 with fibers arrayed at each of the widths ½, ⅝, ¾, ⅞, 1, and 1⅛ inches. The observed strength of the bundles increased as the width of the arrayed fibers increased. The rate of increase was different for the two operators. The average results of the two are shown in Figure 5.

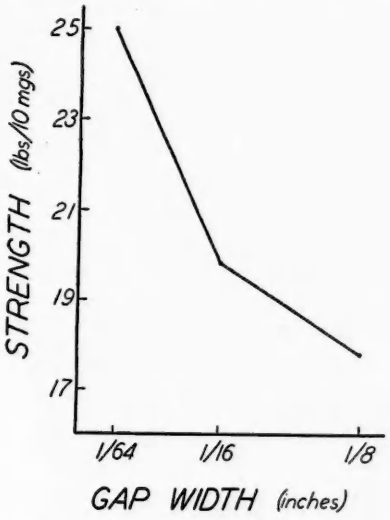

FIG. 6. *Effect of gap width on observed strength.*

The increase in strength between the standard ¾-inch width and 1⅛-inch width was found to be 1.5 pounds per 10 milligrams, or an average increase of 0.25 pound per 10 milligrams for each 1/16-inch increase in bundle width.

Although these values for the rate of increase in bundle strength with bundle width apply only to the particular cottons which were tested, they can be taken to show that bundle width should be controlled to within 1/32 inch if errors due to this cause are to be kept small.

The increase in strength with an increase in bundle width is in direct contrast with the results obtained on the Pressley tester by Shepherd [13] and later by Williams and Painter [11].

A second variation in bundle geometry which affects breaking strength is the degree to which the fibers approach parallelism with each other. In making bundles every precaution is taken to have all the fibers as nearly parallel as possible and perpendicular to the edges of the tape. To determine the effect of nonparallel fibers, the following experiment was performed.

Bundles were prepared in the ordinary manner except that before taping the fibers were spread to a width of 1½ inches at one end, but held to the standard ¾-inch width at the other. Thus the array of fibers was fan-shaped. Control bundles were also prepared.

Comparison of the strengths of these two types of bundles showed the fan-shaped bundles to be significantly weaker than the control bundles. This result would be expected from an examination of the geometry of the bundle. The recorded breaking strength of the fanned bundles represents only that component of the fiber strength which is parallel to the direction of motion of the jaws.

A third factor of bundle geometry which affects breaking strength is the width of the gap between the tapes and of the gap between the jaws. Normally these gaps are 1/64 and 3/64 inch respectively. A series of breaks were made with these gaps equal and set at 1/16 inch and ⅛ inch. A comparison of the observed breaking strengths of these bundles with standard bundles of the same cotton is shown graphically in Figure 6. The breaking strengths of the bundles with the increased gaps are significantly weaker than those of the standard bundles. The decrease in breaking strength averaged 1 pound per 10 milligrams for each 1/64-inch increase in gap width in the range studied. This large value indicates that

it is extremely important to hold the gap width of both tape and jaws constant. This reduction in strength would be predicted from the "weakest link" theory [14]. The shorter length of the fibers held by the tapes and jaws when the gap width is increased may account for some of the observable loss.

This study of gap width was not concerned with the effective or "equivalent" gap, when the term "equivalent gap" is used to mean the distance by which the jaws and tape should be separated in order to give the same breaking strength if the fibers were held without slipping along an infinitely narrow line perpendicular to their length. Since the fibers are held for some distance along their length in the plastic mass of the adhesive, the distance between these imaginary lines would be greater than the gap widths discussed above.

Bundle Strength and the Operator

Although every effort has been made to standardize all elements of the technique, the preparation of the bundles for the flat taped bundle fiber strength test remains something of an art. Results are, then, dependent to some extent on the technician.

It has been found that a new operator may be trained to carry out the flat bundle test in from 4 to 6 weeks. After the steps have been learned the trainee prepares and breaks from 4 to 6 bundles each day. Usually at the end of the training period the standard deviation for four breaks of the standard picker lap cotton has decreased from a maximum frequently of over $\pm$ 1.5 pounds per 10 milligrams to a value of about $\pm$ 0.5 pound per 10 milligrams. The daily picker lap average strength also generally shows a considerable deviation when the operator starts training, but again, at the end of his first month of practice, the daily average strength usually approaches a constant value.

This "constant value" for the daily average strength of the standard cotton is often quite different for two operators. In some instances this difference has been as much as 8 percent. The daily average also has on occasion shown a slow drift for one operator. In each case the total change has always been less than 4 percent and has taken a year to occur.

However, by adjusting all strengths by means of the standard picker lap, as described previously, the adjusted strengths may be kept constant and the difference between the results of two operators is reduced.

TABLE III. COMPARISON OF ACTUAL AND ADJUSTED STRENGTH AS MEASURED BY SEVERAL OPERATORS

Cotton	Operator	No. Breaks	Picker lap moving average (lbs./10 mg.)	Average observed strength (lbs./10 mg.)	Average adjusted strength (lbs./10 mg.)
1*	A	18	23.6	24.2	25.6
	B	18	24.0	25.4	26.5
2*	A	15	23.6	23.4	24.8
	B	15	24.1	24.0	24.9
3*	A	10	23.4	23.7	25.4
	C	10	25.7	26.5	25.7
4*	A	9	23.4	23.3	24.9
	C	9	25.7	25.6	24.9
5*	A	10	23.4	23.5	25.1
	C	10	26.1	25.7	24.6
6**	A	7	23.7	26.1	27.5
	B	5	23.9	27.0	28.3
7**	A	5	23.0	24.9	27.2
	B	4	23.4	25.8	27.6
8**	A	5	23.4	25.2	26.9
	C	5	25.3	27.7	27.4
9**	A	5	23.3	23.8	25.5
	C	4	25.8	26.8	26.0

* Tests made on same samples by each operator.
** Tests made on same lot of cotton, but on different samples, by each operator.

This is illustrated in Table III, in which the actual and adjusted strengths are compared for several operators. The data in the table illustrate the important role that the adjustment of strength plays in reducing operator differences. It also illustrates the variation which is common between the strengths of two groups of bales from the same source.

A skilled operator can make and break 40 bundles in 7½ hours. The average for all operators is 35 and this is the number that is usually scheduled. Results depend upon the operator; hence it is not desirable for him to make breaks when he is tired or indisposed.

Dependence of Bundle Strength on the Apparatus

Bundle strength depends to some extent on the apparatus used. It has been found that different styles of combs produce different breaking strengths for the same cotton. The condition of the comb is

also important. Rusty or bent teeth cause a noticeable change in breaking strength.

The observed strength will vary with the machine used to break the bundles. This dependence is, of course, well recognized and all standard strength testing techniques specify machine requirements.

Another source of variation results from different jaw pressures applied by the machine used in breaking the bundles. The breaking strength of the flat taped bundles has been observed to increase to a maximum value when jaw pressure is increased, and then to decrease with additional jaw pressure. The increase in breaking strength with increasing jaw pressure can be described as a decrease in the "equivalent gap" since the fibers become more securely held at the higher pressures. The subsequent decrease probably results from damage to the fibers.

Since jaw pressure is dependent upon the operator's judgment, there is some possibility of variation in breaking strength due to this cause. A torque wrench could be used to tighten the jaws to a constant pressure and in this way much of this variation could be eliminated. However, it has been found that the change in breaking strength with change in jaw pressure is not rapid at the peak; therefore it is felt that with experience and reasonable care this variation can be kept small with respect to the other variable factors that are present. The control chart for the standard picker lap will show any tendency of the jaw pressure to drift far from the standard.

Acknowledgment

Much of the work reported here has been done over a period of several years. Contributions have at one time or another been made by almost all members of this laboratory. Acknowledgment is made to them collectively for the part they have played in this work.

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Mechanical Properties of Textiles, V*

The Three-Element Model Under Any Experimental Condition

Henry Eyring[1] **and George Halsey**[2]

Contribution of the Textile Foundation and Princeton University, Frick Chemical Laboratory, Princeton, New Jersey

IN preceding papers [1, 2] the three-element model of Figure 1 is shown to be a satisfactory model to account for the stress-strain properties of many textiles.

In these papers the only type of experiment considered was one in which a linear relationship existed between force, elongation, and time:

$$pF + ql + rt = 0,$$

because only this restraint makes the equations amenable to simple treatment. In practice, it is often desirable to calculate behavior that is characterized by its dependence on any restraint, assuming in this discussion that the constants of the model have been evaluated from simple experiments of the type of equation (1) and hence are available for computation.

However, in solving even the simplest cases analytical difficulties are met with, and it is of interest to consider here simple point-by-point methods. The method of synthesizing the total force, F, from the partial forces, f, on the dashpot and spring in series, and $F-f$, on the single spring will be employed, as in the earlier papers.

If the restraint is of the form

$$l = R(t, F)$$

then

$$F - f = k_2 l = k_2 R(t, F).$$

The value of f must be considered with more care.

First the case of constant rate is reconsidered. In the previous papers [1, 2] the real value of f has been shown to be

$$f = \frac{1}{\alpha} \log \left\{ \frac{1 + \dfrac{1+\beta}{\sqrt{1+\beta^2}} \tanh \sqrt{1+\beta^2}\, t}{1 + \dfrac{1-\beta}{\sqrt{1+\beta^2}} \tanh \sqrt{1+\beta^2}\, t} \right\}.$$

Here αf is a dimensionless number. It is the work done by the force f in surmounting the potential barrier divided by the energy of an oscillator kT. β is also dimensionless. It is the rate of forced elongation of the fiber, ρ, divided by the rate the fiber would elongate, K, under no force if all spontaneous elongations occurred and all spontaneous contractions were suppressed.

This curve, or family of curves, depending on β, is adequate to predict the value of f from its initial value, f_0, as long as f_0 is below f_∞ in value.

For values of f_0 greater than f_∞ it is necessary to determine the family of curves where the extreme boundary value $f_0 = \infty$ is employed. The general solution

$$f = \frac{1}{\alpha} \log \{\beta + \sqrt{1+\beta^2} \tanh(bt + c)\}$$

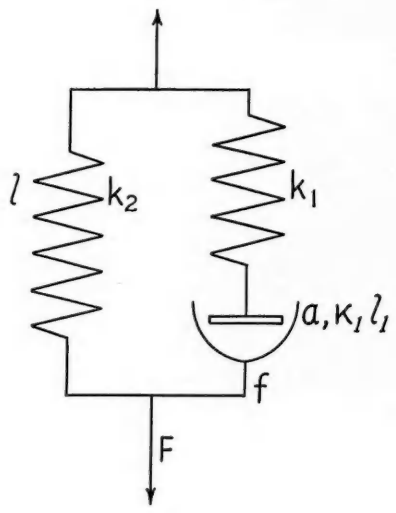

FIG. 1. *The three-element model used here to represent the stress-strain behavior of textiles.*

* The first four papers in this series appeared in the September and December, 1945, and the January and February, 1946, issues.

[1] Director of Research, the Textile Foundation.

[2] Fellow of the Textile Research Institute.

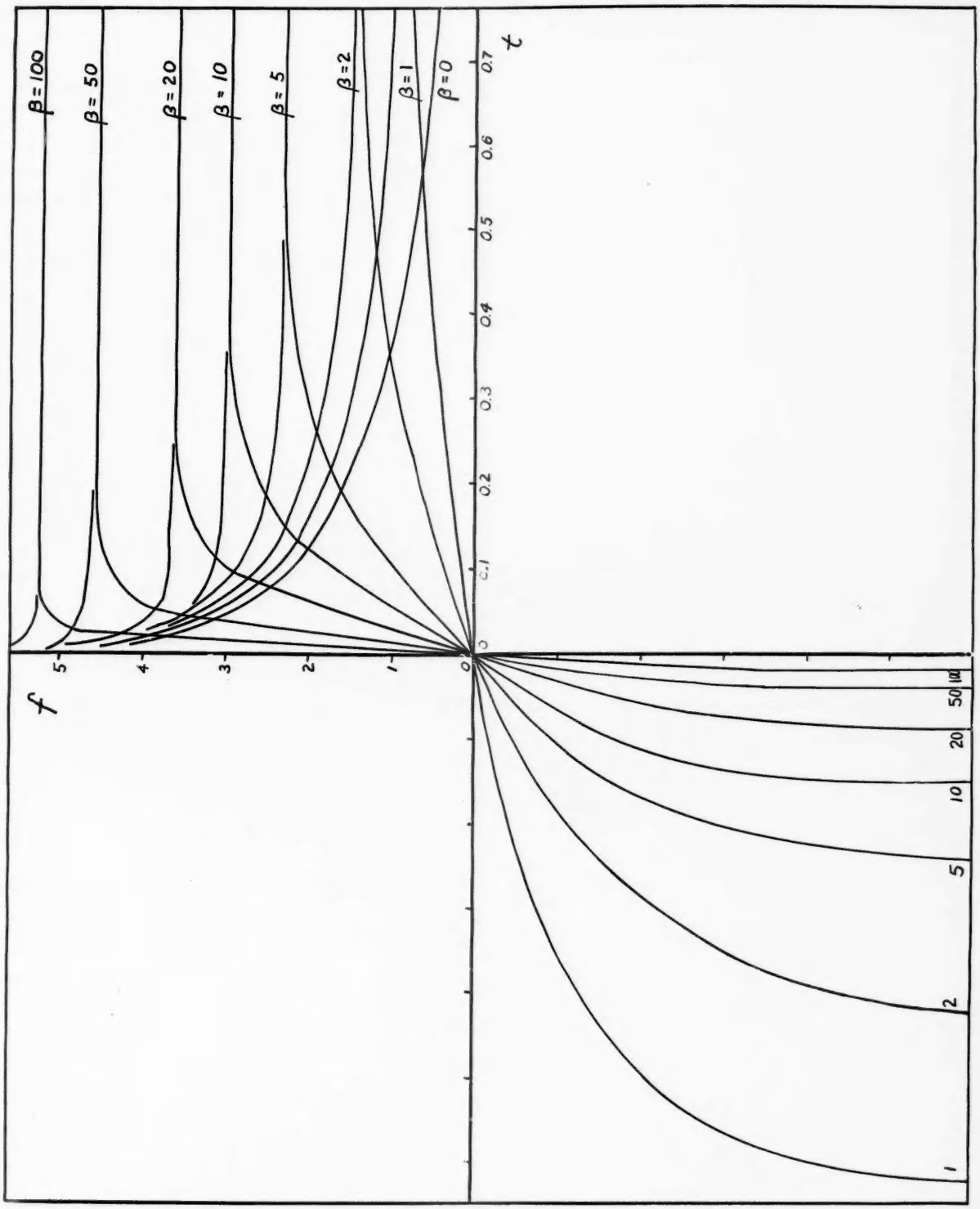

FIG. 2. *The working curves for various values of β from 1 to 100.*

yields at $f = \infty$, $t = 0$

$$\infty = \log \{\beta + \sqrt{1 + \beta^2} \tanh c\},$$

$$c = \frac{\pi}{2}\sqrt{-1}.$$

This yields, as a special solution,

$$f' = \frac{1}{\alpha} \log \left\{ \beta + \frac{\sqrt{1 + \beta^2}}{\tanh bt} \right\}.$$

(The constant b is the $\sqrt{1 + \beta^2}$ to agree in scale with f.) This equation represents a family of curves asymptotic to $t = 0$ and $f' = f_\infty$, because when $t = \infty$

$$f'_\infty = \frac{1}{\alpha} \log \{\beta + \sqrt{1 + \beta^2}\},$$

and for the other set of curves passing through $t = 0, f = 0$

$$f_\infty = \frac{1}{\alpha} \log \left\{ \frac{1 + \dfrac{1 + \beta}{\sqrt{1 + \beta^2}}}{1 + \dfrac{1 - \beta}{\sqrt{1 + \beta^2}}} \right\},$$

and, since

$$\beta + \sqrt{1 + \beta^2} = \frac{1 + \dfrac{1 + \beta}{\sqrt{1 + \beta^2}}}{1 + \dfrac{1 - \beta}{\sqrt{1 + \beta^2}}},$$

$$f'_\infty = f_\infty.$$

These two families, which together cover the entire range of f from $-\infty$ to ∞, are plotted in Figure 2. Thus with a given velocity and initial conditions, subsequent conditions can be predicted at that velocity by following the proper curve. But since

$$l = R(F, t),$$

or

$$\frac{dl}{dt} = \rho = R'(F, t),$$

no longer a constant, it is possible to predict the initial velocity if f_0, F_0 and the constants are known to be

$$\beta_0 = \frac{\rho_0}{K} = \frac{R'(F_0, 0)}{K}.$$

Proceeding along the proper curve β_0 an amount Δt_1, from f_0 gives

$$\Delta(F - f)_1 = \rho_0 k_2 \Delta t.$$

Here k_2 is the force constant of the spring (see Figure 1).

Δf_1 is obtained from Figure 2:

$$\Delta l_1 = \rho_0 \Delta t_1.$$

Then a new β is determined.

$$\beta_1 = \frac{\rho_1}{K} = \frac{R'\{(F_0 + \rho_0 k_2 \Delta t_1 + \Delta f_1), \Delta t_1\}}{K}.$$

Then, from the point $f_0 + \Delta f_1$, curve β_1 is followed for a time Δt_2, and another point is thus constructed.

This process is repeated until the required curve is produced.

Application to Specific Problems

An important problem of the non-linear type is found when a weight bounces on the end of a fiber but not against gravity. The restraint is of the type

$$\frac{d^2l}{dt^2} \equiv \frac{d\rho}{dt} = \mu F,$$

which is not immediately available in the form

$$\rho = R'(F, t);$$

but, assuming an initial value for ρ,

$$\Delta\rho = (\mu F)\Delta t,$$

and subsequent values can be computed.

In Figures 3, 4, 5, and 6, three examples of this type of calculation are presented. They show that the proportional loss of energy is at a maximum for a given set of constants when an intermediate

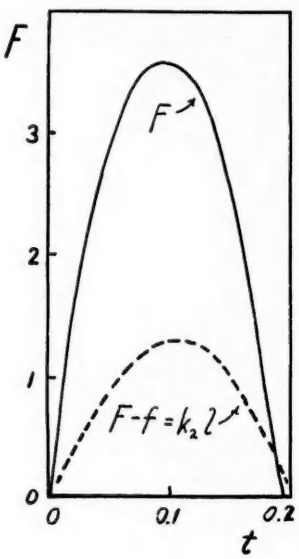

FIG. 3. *A bounce with very little dissipation of energy. (The yield point is not exceeded.)* $\beta_{initial} = 20$; $\beta_{final} = 19$; $\Delta\beta = -100\ F\Delta t$; $k_2 = 10$.

kinetic energy is found in the bouncing weight. At low velocities and low loads the behavior is sensibly elastic. This is also true when the load is so great that the relative force on the dashpot is small. The absolute loss, however, constantly increases with increases in the load and velocity.

If it is desired to consider multiple bounces where the force of gravity returns the weight to strike again, the law must be suitably modified to the form

$$\Delta\beta = (\mu F - G)\Delta t.$$

An example of this type is worked out in Figures 7 and 8. It is carried as far as the accuracy of the particular working diagram, Figure 2, will permit. In order to carry it on over further cycles a diagram covering a more "Newtonian" range of variables would be constructed. If, on the other hand, a more non-Newtonian range of variables had been selected, so that when the range of amplitudes became less than the yield point the value of β were still large, then the remaining vibrations would die out more slowly. This arises because of the spring-like nature of the fiber when operating in a non-Newtonian manner below the yield point. As a general principle, the more non-Newtonian fiber will suffer small attenuation when the amplitude is small, as compared with a more nearly Newtonian fiber.

It is to be noted that all of the equations and examples are expressed in terms of reduced variables. These reduced variables are similar in purpose to the reduced variables of earlier papers of this series, but differ in that only the scale of force values is changed, leaving the relative forces in their proper ratios to one another. Previously, the ultimate values had all been normalized to one in order to simplify computation. This point of view

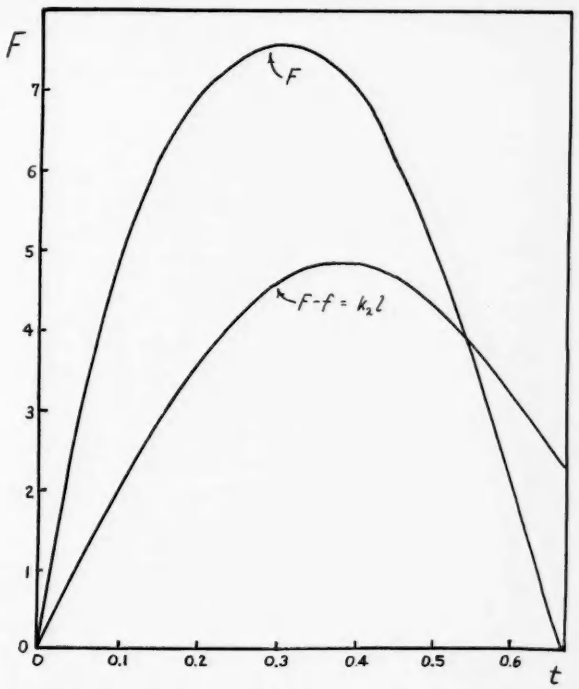

FIG. 4. *A bounce with large dissipation of energy. $\beta_{initial} = 20$; $\beta_{final} = 12.5$. Final energy = 0.39 initial energy. $\Delta\beta = -10$ Ft, ten times the weight in Figure 3; other conditions constant. $k_2 = 10$.*

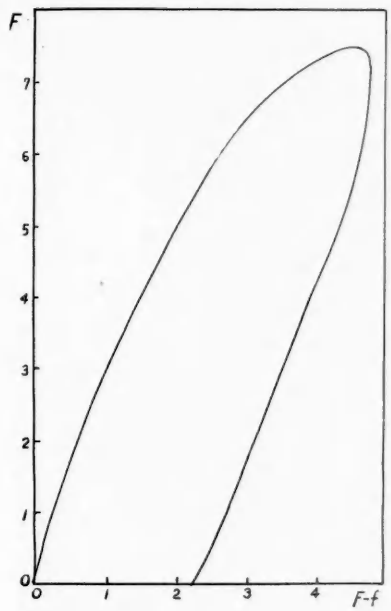

FIG. 5. *Here Figure 4 is replotted as F−f (length) vs. F.*

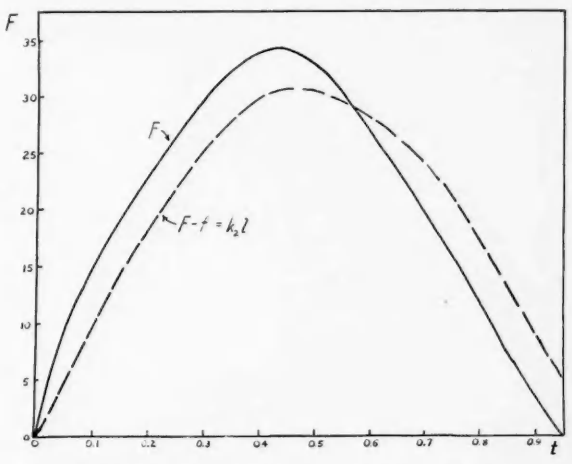

FIG. 6. *The same as Figure 4 except the initial velocity is increased fivefold. The proportional dissipation decreases, the absolute dissipation rises. $\beta_{initial} = 100$; $\beta_{final} = 82$. Final energy = 0.67 initial energy. $\Delta\beta = -10\ F\Delta t$; $k_2 = 10$.*

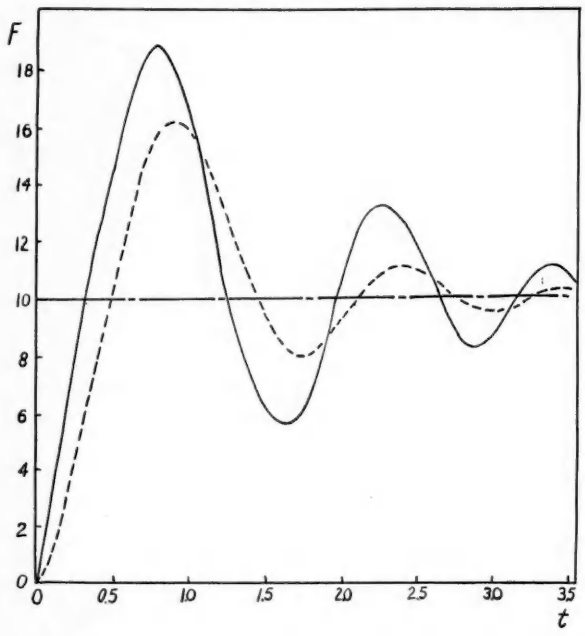

FIG. 7. *Repeated bounces because of gravity.* $\beta_{initial} = 10$; $\Delta\beta = (100 - 100\ F)\Delta t$; $k_2 = 10$.

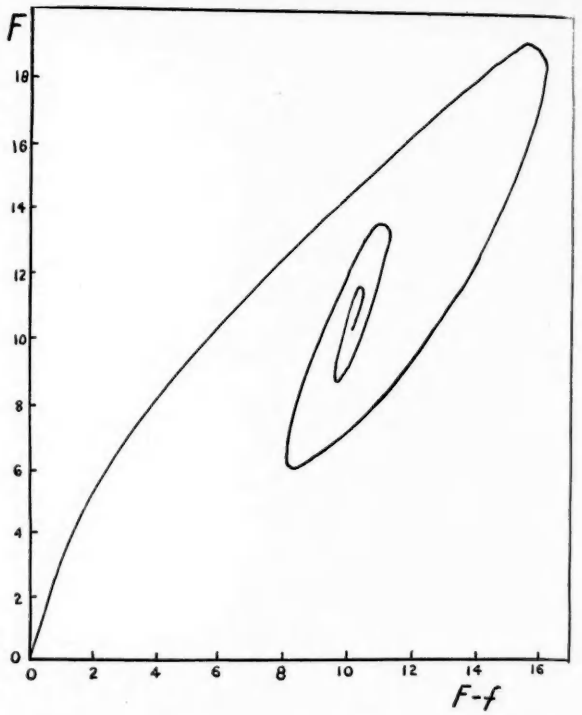

FIG. 8. *Figure 7 replotted as* $F - f$ *(length) vs.* F.

is manifestly undesirable when different rates of elongation are considered together.

Similarly, the time values were normalized previously to the half value of the ultimate force (that is, when $t = 1, f = \frac{1}{2}$), but now the ratios between the initial slopes must be preserved in their proper values. This is made necessary by the new variable that is now considered. Thus, the three conditions defining the old reduced variables were as follows:

when $f = 0, \quad t = 0,$
$f = \frac{1}{2}, \quad t = 1,$
$f = 1, \quad t = \infty,$

and the definitions of the new reduced variables are as follows:

when $f = 0, \quad t = 0,$
$K\alpha k_1 = 1,$
$\alpha = 1.$

The logarithmic functions used in these examples are all to the base e. With these considerations in mind, the units of Figure 2 are defined.

Now, in order to work a specific problem, where the values of the constants are presented in centimeter-gram-second units, it is necessary to reduce the units. First, the value of the force unit is taken, so that α becomes unity in terms of the new force variable. Then, time is taken so that the product $K\alpha k_1$ equals unity, whereupon the variables are reduced. Then $\beta_{initial}$ is computed from $_{initial}$ and K, and k_2 is expressed in terms of reduced force, and the computation begins. The only numbers that characterize a given computation, then, are the experimental restraints, such as inertia (which must again be in reduced units), the value of k_2 in reduced units, and $_{initial}$.

Some general considerations concerning problems involving the oscillating weight are available. When the amplitude is very high, dissipation on an absolute scale will, of course, be high, but, as was observed in Figures 3, 4, 5, and 6, the relative loss is not great, and thus from a relative standpoint dissipation of amplitude will be seen to go through a maximum, corresponding to Figure 4, in the case of a single encounter with the weight.

Concerning the period of oscillation, when the operation of the model is below the apparent yield point, it will approximate the behavior of the two springs in parallel, as is apparent in the almost perfect single encounter of Figure 3. If the yield point is grossly exceeded, then the springiness will

be approximately that of the spring constant k_2 alone. Thus, in a decay, there is a transition from the longer period associated with the weak spring k_2 to the shorter period of the stronger spring $k_1 + k_2$. This appears in Figure 6, where there is a considerable change in period.

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Gibson Island Conferences for 1946

THE ninth summer series of special research conferences on chemistry and allied subjects, under the auspices of the American Association for the Advancement of Science, will be held at Gibson Island from June 17 through August 23, 1946. The general title of the conferences is "Frontiers in Chemistry." Applications to attend the conferences should be sent to Sumner B. Twiss, Wayne University, Detroit, Michigan.

The sessions devoted to textiles will begin on July 8 and continue through July 12. The chairman of this session will be Dr. D. H. Powers and the vice-chairman will be Dr. W. A. Sisson. The program follows:

July 8—"Curl in Woven Textile Fabrics: Its Cause and Control," by Ross Whitman
"The Relation of Fiber and Fabric Structure to Wear Resistance and Durability," by Stanley Backer

July 9—"Some Notes on Cellulose Solvents and Their Application to Special Textile Finishes," by C. L. Mantell
"Cloth Geometry and Its Application to Functional Design," by F. T. Peirce

July 10—"The Effect of Textile Sizing Agents Upon the Physical Properties of Cotton Fabric Laminates," by H. W. Mohrman and R. J. Schatz
"Tensile and Torsional Properties of Textile Fibers," by M. T. O'Shaughnessy and L. G. Ray

July 11—"Load-Deflection-Time Relationships in Textiles," by W. J. Hamburger
"Structural Principles for Resiliency and Recovery in Fibers," by H. Mark

July 12—"Chemical Behavior of Cellulose Under Influence of Retardants at Combustion Temperatures," by S. Coppick, R. W. Little, and J. H. Church

Determination of Iodine on Cloth Treated with Organic Iodine Compounds

Solomon Frankfurt

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THE purpose of this paper is to describe a new method for the determination of iodinated organic compounds deposited on cotton fabrics. It is based on the removal of these compounds from the cloth, bringing them into solution, and estimating the iodine content of the solution.

Niederl and Niederl [1] cite 115 references in various publications concerning the determination of organic iodine compounds. However, only a few of these procedures can be adapted to the problem of quantitative analysis of these iodinated compounds fixed on cotton fabric.

This is true also of the method of Stephanov [2] and its modifications, which are based on splitting off the iodine by the use of sodium in an alcohol medium; furthermore, these methods require 2–3 hours for completion and great care must be exercised in performing the determination.

The method presented here employs ammonium vanadate as catalyst in the process of oxidation with potassium permanganate. After preliminary experimentation, the following procedure was adopted:

0.1–0.2 gram of the iodine compound is put into a 500-milliliter Erlenmeyer flask; then 50 milliliters of 10-percent sulfuric acid and 10 milliliters of 2.5-percent ammonium vanadate solution are added. This mixture is heated. When boiling starts, a saturated solution of potassium permanganate is added, a little at a time, while the flask is agitated. After 10–15 minutes, the evolution of carbon dioxide ceases, and the solution is boiled for 10 minutes more, care being taken that the violet-red color remains. After the oxidation is complete and the solution is cooled, small portions of solid sodium bisulfite are added, and the flask is shaken. A reduction takes place—the red color changes to a dark brown, and then the solution becomes light green. In this way, the different iodine compounds formed in the oxidation are reduced to iodide, which can be determined as silver iodide by precipitation with silver nitrate. After all the excess sulfur dioxide is removed by boiling, silver nitrate and then nitric acid are added. The end determination can be made gravimetrically by collecting the precipitate in a weighted Gooch crucible, or volumetrically by using the Volhard method.

In the method described above, only iodine compounds with high boiling points can be tested; otherwise it is necessary to use a reflux condenser, and to introduce the oxidant through a side arm or funnel.

To test the accuracy of this method, ortho-iodobenzoic acid and iodophenol were used. The results were:

	Amount of Iodine	
	Calculated	Experimental
o-iodobenzoic acid	51.2%	(1) 51.2%
		(2) 51.5%
p-iodophenol	57.7%	(1) 57.3%
		(2) 57.5%

Determination of Iodine on Cotton Fabrics

After a convenient method for the determination of iodine in organic compounds was established, the logical method of determining the amount in fabrics treated with iodine compounds was the removal of the compound from the cloth in a suitable solvent, and an analysis by the procedure described above.

The iodine compound was split off from the cloth by slow heating with 10-percent sulfuric acid.

To prove that all of the iodine was removed from the cloth, it was necessary to make an iodine determination (1) for an aliquot part of the liquid without the cloth and (2) also for the total volume of liquid together with the cloth.

In the procedure in which the cloth was left in the liquid, after adding the solution of ammonium vanadate, the potassium permanganate was cautiously added to avoid the evolution of excess gas, taking

care that the liquid remained a violet-red color during the boiling.

The reaction subsides after 15–20 minutes of slow heating, and then the temperature is raised to boiling for 5 minutes. If, after treating with sodium bisulfite, the cloth remains brown-black in color, more powder should be added, and the flask should be heated after each addition until the cloth becomes clear in color. There is no variation in the rest of the procedure. As will be shown below, comparable results from treating with 10-percent sulfuric acid, as described here, are obtained.

Depending upon the amount of iodine on the cloth, the weight of the sample may vary from 1 to 5 grams. The sample is cut into small pieces and then put into a 500-milliliter Erlenmeyer flask, 100–250 milliliters of 10-percent sulfuric acid (exact measurement) are added, and the contents of the flask are heated slowly for 25 minutes on a water bath.

To keep the volume unchanged, the flask is attached to a reflux condenser, which is loosely closed with a watch glass. The boiling is continued for 5 minutes more. After cooling, an aliquot volume is taken for determination by the procedure described above. Following is a compilation of results obtained on three fabrics. The amount of iodine in each was determined by analysis of an aliquot portion of the liquid separated from the cloth, first gravimetrically and then volumetrically, and of all of the liquid together with the cloth:

Cloth C–193:

Portion of liquid separated from cloth (volumetrically)	0.33% I
Portion of liquid separated from cloth (gravimetrically)	0.38% I
Total liquid together with cloth	0.38% I

Cloth 5B–83:

Portion of liquid separated from cloth (gravimetrically)	0.76% I
Portion of liquid separated from cloth (volumetrically)	0.77% I
Total liquid together with cloth	0.77% I

Cloth 5B–84:

Portion of liquid separated from cloth (gravimetrically)	0.76% I
Portion of liquid separated from cloth (volumetrically)	0.77% I
Total liquid together with cloth	0.78% I

Conclusions

1. The presence of ammonium vanadate as a catalyst, and the subsequent use of sodium bisulfite, make possible the conversion of the iodine of organic compounds to its ionic form.

2. A convenient way of determining iodine on cotton cloth treated with organic iodine compounds consists in boiling the cloth with 10-percent acid for 25 minutes, and treating the solution in the same manner as a solution of an organic compound.

This method can be used for determination of only iodine on the cloth; the presence of other halogen ions would interfere with the test results, because they give similar reactions with silver salts.

Literature Cited

1. Niederl, J. B., and Niederl, V., "Micromethods of Quantitative Organic Elementary Analysis," New York, John Wiley and Sons, 1942. P. 179.
2. Umhoefer, R. R., *Ind. Eng. Chem., Anal. Ed.* **15**, 383 (1943).

Book Reviews

Wood Chemistry. Edited by Louis E. Wise, of The Institute of Paper Chemistry, Appleton, Wisconsin. A.C.S. Monograph Series No. 97. 900 pages. New York, Reinhold Publishing Corporation, June, 1944. Price, $11.50.

(Reviewed by Elwin E. Harris, U. S. Forest Products Laboratory)

The general field of wood chemistry has expanded greatly in the last few years as wood has been called upon to fill an increasing role in the needs of our nation. In *Wood Chemistry,* the views of some of America's best-known specialists in the field are brought together. The book contains 25 chapters and its object is to present as complete a picture as possible of the properties and possibilities of wood as a chemical material.

Part I, "The Growth, Anatomy, and Physical Properties of Wood," gives the reader a conception of wood as a complex material of plant origin. The functions of the various parts of the tree, how the tree grows, and the differences between hardwoods and softwoods are described. A chapter on the physical properties of wood discusses those properties that are of importance in the use of wood as an engineering material.

Part II, "Components and Chemistry of the Cell Wall," deals with the principal components of the cell wall—cellulose, hemicellulose, and lignin—including their chemical constitution, relative relationships in the cell wall, chemical reactions, changes that occur when it is subjected to various chemical actions, physical-chemical properties, and the production and properties of derivatives. Comparisons are made frequently to cellulose from cotton, in order to bring out differences and similarities. Information on x-ray studies and methods of molecular weight determination is given for both cellulose and its derivatives. Methods of isolation and study for both hemicellulose and lignin are described. Research on these two components of wood has not progressed to the state of that for cellulose, and the authors of the two chapters illustrate that fact by giving the various points of view.

Part III, "The Extraneous Substances," points out the various types of materials that occur in wood, such as volatile oils, resins, fats, fatty acids, sterols, waxes, dyes, pigments, tannins, free carbohydrates, saponin, and other extractives. The author has developed the field very well and, in addition, presents a procedure developed by himself for the isolation of these various extraneous substances.

Part IV, "Surface Properties of Cellulosic Materials," reviews such factors as adsorption of gases, water vapor, other vapors and liquids, adsorption hysteresis, effect of temperature on adsorption, thermodynamics of adsorption, fiber-saturation point, selective adsorption, internal surface, swelling, shrinking, antishrink treatments, electrical properties, capillary structure, diffusion, drying and chemical seasoning. Comparative data for cotton cellulose are frequently given.

Part V, "The Chemical Analysis of Wood," gives various methods employed in the analysis of wood and wood components and their significance in the chemistry of wood.

Part VI, "Wood as an Industrial Raw Material," covers the use of wood for fuel, for the production of chemical products through wood distillation, for the production of pulp and paper by chemical pulping, for sugar production by hydrolysis, for the production of oxalic acid by caustic fusion, for liquid products by hydrogenation, and for wood plastics after chemical pretreatment.

Chapters 24 and 25 describe the decomposition of wood and wood products as brought about by various organisms and fungi.

Each chapter contains a long list of references that show the scope of the work covered in the book and the thoroughness of the authors in the development of their subjects.

A considerable part of this book should be of interest to textile chemists.

The Pirates Will Get You. Sylvan Gotshal and Alfred Lief. New York, Columbia University Press, 1945. 103 pages. Price, $2.00.

(Reviewed by Robert B. Evans)

Beauty and style are key factors in the salability of textile products used for clothing, for household

purposes, and for many industrial applications. Yet originality in design has never received adequate protection in the laws of the United States. Under a specific grant of power from the Constitution, Congress passed laws on both patents and copyrights as early as 1790. With the passing of time, the courts extended the area of copyrighting to include popular songs, advertisements, works of art, designs for works of art, and photographs, phonograph records, motion picture films, and radio broadcasts, but not designs for industrial use. Although a design patent law was passed in 1842, the Patent Office and courts have ruled that an element of novelty tantamount to invention must be proved, and obtaining a design patent involves search, delay, and probable intervention proceedings.

The authors describe the many efforts which have been made during recent years to obtain protection for original designs, both by legal and extralegal means. Several efforts have been made to enact a law which would provide copyright protection for such designs, and although there has been virtual unanimity that legal protection is desirable, these efforts have failed thus far because of disagreement as to what form the law should take. Lacking statutory protection, one of the leading silk manufacturers sought in the later 1920's to invoke the common law, on the ground that a duplicator of their original design was guilty of unfair competition, but the courts ruled against it.

An attempt was made to have the Federal Trade Commission include design piracy in its list of recognized unfair methods of competition, but this was also unsuccessful.

The establishment of the Design Registration Bureau in 1928 represented an effort by industry to secure the protection which could not be had from the law. Designs of members were cleared for originality by this Bureau, and an agreement was made with printers whereby the latter would refuse to print any design not registered by the Bureau. In 1939 the Fashion Originators' Guild of America set up a system of dress design registration, providing for black-listing retailers who sold unauthorized copies of registered designs. The Federal Trade Commission, however, secured court action against this action, as a conspiracy to suppress competition.

France recognized property rights in silk designs as early as 1737, and a basic copyright act was enacted in 1793 which extended protection on original designs to all industries. Legal protection afforded then and later was a highly influential factor in establishing French leadership in textile designing. In England, a two months' copyright was granted for fabric designs as early as 1787, and in 1907 Parliament provided copyrights for five years (plus two further terms of five years each), affording registration for every new or original design which might be applied to any article.

The authors make a clear case that action by Congress is long overdue in the matter of providing protection for designs and designers against piracy. Such action is needed if American aspirations to leadership in style and fashion are to be realized.

ABSTRACTS

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A list of periodicals, the abbreviations used in references to articles, and the addresses of publishers of English language publications is given on page 84 of the February, 1946, issue.

ANALYSIS: TESTING: LABORATORY METHODS

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Analysis of Grease Wool

The analysis of grease wool for clean content. G. C. LeCompte, M. E. Coe, and B. L. Gold. *Am. Dyestuff Reptr.* **34**, 383–4 (Sept. 24, 1945).

An error is introduced in the estimation of impurities in scoured wool if the sample under analysis has not been thoroughly scoured; this error is believed to be due to a humus or topsoil dust adhering to the fiber which is insoluble in ethanol and yields very little ash on ignition. It is therefore suggested that at least one rescouring according to a standard method be given to avoid this overestimate of clean wool content. Experimental data proving the value of this procedure are presented. K. S. Campbell

Text. Research J. Mar. 1946

Testing Color Transference

A new tool for evaluating color transference. W. A. Holst. *Am. Dyestuff Reptr.* **34**, P500–1 (Dec. 3, 1945).

A device known as the "AATCC Chart for Measuring Transference of Color" is described. Its purpose is to provide an accurately graduated series of color specimens for direct comparison with a test cloth (originally white) to which color has been transferred from a dyed sample during test for fastness to crocking, sublimation, washing, perspiration, etc. It consists of 24 color chips mounted on cardboard in horizontal rows; the color chips are selected from the *Munsell Book of Color* and comprise 6 colors, namely, neutral gray, red, yellow, green, blue, and purple, all in 4 depths ranging from a light tint to a moderately deep shade. A mask for convenient matching and instructions for most effective use of the chart are provided.

K. S. Campbell

Text. Research J. Mar. 1946

Copper Naphthenate

A study of the effect of leaching on the rotproofing efficacy of copper naphthenate. C. H. Bayley and M. W. Weatherburn. *Am. Dyestuff Reptr.* **34**, 457–60, 471–3 (Nov. 19, 1945).

When cotton fabrics containing copper naphthenate are subjected to leaching in water, the ability of the samples to withstand microbiological attack in the soil burial test is impaired. It has been shown that this effect is not the result of loss of copper during the leaching treatment but appears to be associated with a change in the copper naphthenate whereby a portion of the copper is converted into a solvent-insoluble form. The effect does not appear to be dependent upon the pH of the water used in the leaching process. The presence of wax reduces the effect to insignificant proportions while the presence of asphalt does not materially reduce the effect. Authors

Text. Research J. Mar. 1946

Electron Diffraction

High dispersion electron diffraction by primary magnification. G. L. Simard, Charles J. Burton, and R. Bowling Barnes. *J. Applied Phys.* **16**, 832–36 (Dec. 1945).

A method for attaining high dispersion in electron diffraction is presented. High dispersion may be obtained by primary magnification of a diffraction pattern formed in the normal manner at the object plane of a magnetic or electrostatic lens. Dispersion may be varied continuously by changing the lens current or voltage. The design of diffraction cameras of this type is discussed and their value in diffraction problems pointed out. The validity of the method is established

by diffraction patterns obtained using a modified electron microscope adapter. Authors
Text. Research J. Mar. 1946

Insect Repellents

Evaluation of fabric pest deterrents. Tentative method. AATCC. *Am. Dyestuff Reptr.* **34**, P400–3 (Oct. 8, 1945).

A tentative method of test is described which covers the biological procedure for determining the resistance of fabrics or yarns which contain fibers susceptible to webbing clothes moths' and black carpet beetles' larvae. The extent of damage to the specimens is determined by visual examination, weight of excrement deposited by the larvae, number of larvae remaining alive, and by the loss in weight of the test specimen. (Because the webbing clothes moth has been found to react differently to different chemicals, the excrement weight method cannot be used for this pest.) A suitable cabinet for a life cycle incubation test is described. Tentative procedures also are offered for rearing and handling the black carpet beetle and the webbing clothes moth. K. S. Campbell
Text. Research J. Mar. 1946

Evaluation of compounds designed to increase the resistance of fabrics and yarns to insect pests. Tentative method. ASTM and NAIDM. *Am. Dyestuff Reptr.* 34, P403–4 (Oct. 8, 1945).

A number of use tests for fabric pest deterrents are described, after subjection to which the specimen must be retested for resistance to insect pests by the AATCC Tentative Method for Evaluation of Fabric Pest Deterrents. The use tests include: duration (length of time of exposure for which protection is satisfactory), washing, drycleaning, hot pressing, light, abrasion, sea water, and perspiration. Classes of change in the treated specimen are set up for certain of the tests. K. S. Campbell
Text. Research J. Mar. 1946

Starch Fractionation

The fractionation of starch. Thomas John Schoch. *Advances in Carbohydrate Chemistry* **1**, 247–77 (1945) (through *Bull. Inst. Paper Chem.* **16**, 163 (Dec. 1945)).

Several methods of fractionating starch are reviewed and particular stress is placed upon the recently developed butanol precipitation procedure (cf. *B.I.P.C.* **13**, 249). An improvement in the purity of the fractions may be obtained by replacing butanol with Pentasol, a commercial mixture of various primary amyl alcohols. A careful study of Meyer's aqueous leaching method has shown that only a partial fractionation of linear and branched polymers is obtained by this method. The linear fraction is rather badly contaminated with the branched fraction, especially at higher temperatures. The following properties of the fractions of starch are discussed: solubility, retrogradation, x-ray diffraction patterns, dichroism of flow, viscosity, ultracentrifuge behavior, alkali lability, hydrolysis, methylation, β-amylase conversion, and Schardinger dextrin formation. A number of pertinent unsolved problems of starch chemistry are mentioned. 73 references.
Text. Research J. Mar. 1946

Titration Curves of Wool

Data on wool-acid-water relationships. K. S. LaFleur. *Am. Dyestuff Reptr.* **34**, 443–7, 452 (Nov. 5, 1945).

Data obtained by adding varying amounts of acid to a number of baths containing a fixed amount of wool and determining the apparent loss of acid from the bath are presented in the form of titration curves showing the loss of acid as a function of pH. Hydrochloric, sulfuric, oxalic, and phosphoric acids were used. Results agree approximately with those of Loeb, who performed similar work with other proteins in an effort to establish the stoichiometric nature of acid-protein combination. There can evidently be no strict agreement between the theoretical basic dissociation curve of wool and any empirical wool-acid combination curve. K. S. Campbell
Text. Research J. Mar. 1946

Graphic Sliver Tester

Investigating the short-period irregularities in cotton slivers and rovings. Anon. *Text. Recorder* **62**, 38–40 (July 1945).

This article describes the graphic sliver tester, a machine which is widely used in the American cotton spinning industry for determining the variations. The increasing importance of short-period variations in cotton spinning is emphasized, and it is pointed out that in the modernization of testing equipment there is a definite need for such a machine as that described. Reference is made to recent improvements in the sliver tester for both research and mill work.
Text. Research J. Mar. 1946 Author

CHEMICAL AND PHYSICAL RESEARCH

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Fermentation of Cellulose

The fermentation of cellulose and similar carbohydrates by thermophilic bacteria. Lennart Enebo and Harry Lundin. *The Svedberg* (Mem. Vol.) 438–55 (1945) (through *Bull. Inst. Paper Chem.* **16**, 125 (Dec. 1945)).

A description of the nature, occurrence, types, and growth characteristics of the thermophilic cellulose-fermenting bacteria is presented, including a brief classification. The principal products formed as a result of thermophilic cellulose fermentation are ethanol, butanol, and formic, acetic, butyric, and lactic acids. It is shown that the medium should not contain more than 3 to 4% of cellulose if it is to be entirely fermented and that native wood cellulose is not fermentable without special preparation to remove the lignin. The accumulation of fermentation products slows down bacterial action and suggestions have been made for the re-

moval of the products during the actual fermentation. Sulfite and sulfate pulps, straw, sugar-beet pulp, corn cobs, fresh bamboo, and fresh grass are mentioned as substances which can be fermented readily. The cost of recovery of the fermentation products is small in the case of ethanol and acetic acid and, with favorable conditions, their recovery may be economically feasible. 27 references.

Text. Research J. Mar. 1946

Sulfuration of Sodium Cellulose

Sulfuration of sodium cellulose. Germano Centola. *Ann. chim. applicata* **31**, 525–31 (1941); *C.A.* **39**, 1756–7 (Apr. 20, 1945) (in Italian; abstract in English; abstract only available) (through *Bull. Inst. Paper Chem.* **16**, 157 (Dec. 1945)).

Treatment of mercerized cellulose with a saturated sodium sulfide solution at 20° C yields compounds (*I*) which are identical with alkali cellulose (*II*) obtained by the action of alkali hydroxides upon cellulose as to crystal structure and chemical composition. Treatments of *I* and *II* with carbon disulfide yield products whose related structure and solubility are vastly different from each other. In each case this may be traced back to the difference in mother liquors that are retained in large measure on the surface and in the intermicellar space of the fibers. In normal *II* there is a large excess of alkali hydroxide, whereas in *I* there is an excess of sulfur and sodium sulfide, but only the stoichiometric quantity of alkali hydroxide. The fact that the alkali celluloses give different products with carbon disulfide supports the hypothesis that, on sulfuration of the normal sodium cellulose, the whole mass of the cellulose is acted upon, and that the viscose is formed from a macromolecular solution of xanthate.

Text. Research J. Mar. 1946

Wratten Light Filters

Colorimetric specifications of Wratten light filters. David L. MacAdam. *J. Opt. Soc. Am.* **35**, 670–5 (Oct. 1945).

I.C.I. tristimulus values and trichromatic coordinates, dominant wave lengths, and purity for 3 illuminants are listed for 115 Wratten filters for which spectral transmittance values are published in the 17th (1944) edition of the Kodak booklet, "Wratten Light Filters." The illuminants are I.C.I. A and C and an artificial daylight consisting of a lamp at 2,360° K with Wratten filter No. 78. Two figures illustrate the distribution of the chromaticities of these filters for A and C illuminants. D. Nickerson

Text. Research J. Mar. 1946

Crystal Forms of Paraffin

Crystal behavior of paraffin wax. S. W. Ferris and H. C. Cowles. *Ind. Eng. Chem.* **37**, 1054–62 (Nov. 1945).

Pressing and sweating are two important industrial processes used in separating paraffin oils and waxes. It has been found that pressing is successful only with waxes which crystallize in plates and sweating with waxes which crystallize as needles. Many slack waxes do not crystallize in suitable forms and no satisfactory explanation of the crystal form obtained has been offered. It is suggested that the composition of slack waxes is more heterogeneous than has been previously assumed, consisting of hydrocarbon of 3 series, those with straight chains or chains with short branches crystallizing in plates, those with cyclic structures crystallizing in needles, and those with long-branched chains forming mal crystals. If but one type is present the crystal form remains the same regardless of the amount or type of solvent. If the types are mixed and if solubility relationships are such that more than one type of crystal can form simultaneously, either the needle or mal can impress its form on the plate. If sufficient solvent is present to maintain needles and mals in solution until plates are well established, mals and needles can then deposit upon and thus take the form of plates. A. R. Macormac

Text. Research J. Mar. 1946

Phosphorus in Wheat Starch

The extraction of fat and phosphorus from wheat starch. Leo Lehrman. *J. Am. Chem. Soc.* 67, 1541–2 (Sept. 1945).

Extraction of raw and disintegrated wheat starch with methanol removes most of the fat and phosphorus. Extraction of disintegrated wheat starch with 80% dioxane-water solution (constant boiling mixture) removes all the fat but not all the phosphorus. This shows that a small amount of the phosphorus is present not as a phospholipid, but is possibly linked in some way with the starch. The extracted starch is more nearly free of phosphorus than any starch previously reported in the literature. Author

Text. Research J. Mar. 1946

Emulsion Polymerization

The mechanism of emulsion polymerization. I. The effect of persulfate concentration in the emulsion polymerization of styrene. I. M. Kolthoff and W. J. Dale. *J. Am. Chem. Soc.* **67**, 1672–4 (Oct. 1945).

The rate of emulsion polymerization of styrene has been investigated in the absence of oxygen at 30° C. It was found that the rate of conversion is proportional to the square root of the concentration of the persulfate which was used as the "catalyst." In this respect the kinetics of the emulsion polymerization of styrene is comparable to that of bulk polymerization. At a given persulfate concentration the rate remains unaffected by the presence of a chain transfer agent like mercaptan when the concentration of the latter varies between zero and 2 parts per 100 parts of styrene. This was anticipated on the basis of the classical picture of the bulk polymerization of styrene. Authors

Text. Research J. Mar. 1946

Kinetics of Polymerization

Relative polymerization reactivity of unsaturated compounds. T. Alfrey and E. Merz. *Polymer Bulletin* **1**, 86–9 (Oct. 1945).

By analyzing the copolymers ob-

tained from 2 different, known mixtures of monomers *A* and *B*, it is possible to calculate rates of propagation of the polymerization of monomer *A* with the *B* free radical. This has been done for the styrene free radical using data in the literature. The following reactivities are obtained, assuming that styrene has a reactivity of 1.0 with the styrene free radical: maleic anhydride 24, dichlorostyrene 5.0, methyl methacrylate 2.0, methyl acrylate 1.3, styrene 1.0, diethyl chloromaleate 0.4, and diethyl maleate 0.2. For other free radicals the order of reactivity would not be the same. Thus, styrene reacts more rapidly with the methyl methacrylate free radical than does methyl methacrylate. E. D. Klug

Text. Research J. Mar. 1946

Viscosity of Vinyl Polymers

Effect of solvent type and concentration on the viscosity of polyvinyl chloride—acetate copolymer. A. G. Jansen and B. P. Caldwell. *Polymer Bulletin* **1**, 120–5 (Oct. 1945).

The viscosity-concentration curves for Vinylite VYNW and some of its fractions in cyclohexanone and methyl ethyl ketone were determined (concentrations from 0.2 to 10 g./100 cc. solvent) at 26° C, 41.8° C, and 60° C. Intrinsic viscosities were greater in cyclohexanone (good solvent) than in methyl ethyl ketone (poor solvent). This is due to chains being more uncoiled and therefore exerting more resistance to flow in a good solvent. The viscosity of the polymer or its high-molecular-weight fractions dissolved in methyl ethyl ketone increased more rapidly with concentration; at high concentrations the viscosity concentration curves in the 2 solvents intersect. However, with low-molecular-weight fractions the curves are substantially parallel. The more rapid increase in viscosity in the poor solvent is due to gelation caused by small amounts of very high-molecular-weight material forming polymer-polymer contacts. Calculations of average molecular weights are made. E. D. Klug

Text. Research J. Mar. 1946

Vinylamine Polymers

Polymerization of nitro-olefins. The preparation of 2-nitropropene polymer and of derived vinylamine polymers. A. T. Blomquist, W. J. Tapp, and John R. Johnson. *J. Am. Chem. Soc.* **67**, 1519–24 (Sept. 1945).

The object was the preparation of a linear polymeric amine with recurring primary amino groups attached directly to a long carbon chain such as $(-CRNH_2-CH_2-)_n$. 2-nitropropene was polymerized in the presence of aqueous potassium bicarbonate solution to give a pale yellow microcrystalline solid probably of relatively low molecular weight. Catalytic hydrogenation of the 2-nitropropene polymer in dioxane with Raney nickel under mild conditions gave a water-soluble polymer which appears to be a linear polymer with primary amine groups, composed of 24–28 recurring 2-amino propene units. Under more drastic conditions extensive deamination takes place and polymers of lower molecular weight are formed which are soluble in dioxane. A dioxane-insoluble product is also formed. The latter is being investigated. A. R. Macormac

Text. Research J. Mar. 1946

Polythene

Texture of polythene. C. W. Bunn and T. C. Alcock. *Trans. Faraday Soc.* **41**, 317–25 (June 1945) (through *Chem. Abstr.* **39**, 5149[5] (Nov. 20, 1945)).

X-ray diffraction patterns were determined at temperatures up to the m.p. (~120°). The proportion of amorphous to crystalline material increases above 80°. The *a* edge of the orthorhombic unit cell of the crystalline part increases in length from 7.42Å at 18° to 7.65Å at 100°. The *b* axis remains between 4.93 and 4.95Å. Evidence obtained from using the polarizing microscope between crossed Nicols shows a spherulitic aggregation of crystals—i.e., a large number of crystals radiating in all directions from a point—a particular direction of each crystal lying consistently along a radius of a sphere. The size of the spherulites varies greatly with the type of polythene and the manner of preparation of the film. The temperature at which the material on heating becomes isotropic varies with different specimens; the highest temperature observed in any specimen was 126°. A mechanism of cold-drawing is discussed.

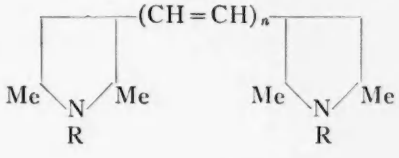
Text. Research J. Mar. 1946

Pyrrolocyanines

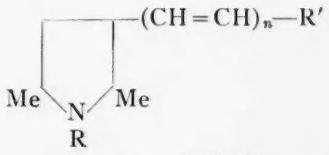
Color and constitution. VI. Pyrrolocyanines. L. G. S. Brooker and R. H. Sprague. *J. Am. Chem. Soc.* **67**, 1869–74 (Nov. 1945).

Symmetrical (*I*) and unsymmetrical (*II*) cyanines have been prepared from 1-ethyl and 1-phenyl-2,5-dimethyl pyrrole, linkage having been effected through the β position of the pyrrole ring. R′ in formula *II* was the benzoxazole, bensothiazole, indolenine, 4-quinoline, or 4-pyridine nuclei. The values of $\lambda_{max.}$ of the unsymmetrical cyanines were less than the values calculated from the mean of related symmetrical dyes. The difference between the observed and calculated values is called the "deviation." This deviation indicates that the order of basicity is indolenine < benzoxazole > benzothiazole. The deviations of the 4-quinoline and 4-pyridine are still greater but direct comparison in these cases is not permissible because of the longer conjugate carbon chain. Longer polymethine chains joining the nuclei also increase the deviation.

(*I*)



(*II*)



A. R. Macormac

Text. Research J. Mar. 1946

Impact Strength of Ropes

Impact strength of nylon and sisal ropes. Sanford B. Newman and

Helen G. Wheeler. *J. Research Natl. Bur. Standards* **35**, 417–31 (Nov. 1945.)

Static and impact tests were made on spliced specimens of $\frac{7}{16}$-inch-diameter, three-strand nylon rope and $\frac{9}{16}$-inch-diameter, four-strand, sisal rope. The stretch of the ropes under impact and static loading up to failure was measured, and from these data energy-stretch behavior was determined. It was found that the energy required to cause failure under impact loading was greater than the energy required to cause failure under static loading. The stretch of the rope at failure was practically the same under impact and static loading. The results of these tests indicate that energy values computed from static tests of these ropes give a safe estimate of the performance of the rope under impact loading. Authors

Text. Research J. Mar. 1946

Infra-Red Studies of Rubber

Some infra-red studies on the vulcanisation of rubber. N. Sheppard and G. B. B. M. Sutherland. *Trans. Faraday Soc.* **41**, 261–71 (Apr.–May 1945).

Infra-red absorption spectra have been determined between 2 and 18μ for the following materials: (a) natural rubber, (b) natural rubber +sulfur and/or various accelerating agents, before and after vulcanization, (c) natural rubber mixes containing carbon black, before and after vulcanization. The accelerating agents studied were zinc oxide, Santocure, and stearic acid. New bands have been detected in natural rubber at 3.1, 4.98 and 16.6–17.7μ. Evidence has been found for the existence of stearate ions in rubber mixes to which zinc oxide and stearic acid have been added. The addition of stearic acid alone to natural rubber also gives rise to a band in the position associated with the stearate ion (6.52μ). The explanation of this phenomenon is not clear. Vulcanized rubber shows two bands at 10.4μ and 17μ which are not present in uncured rubber. The latter is probably associated with C—S bonds. Vulcanization produces very little effect on the C=C frequency of rubber at 6μ, so that appreciable unsaturation would appear to exist in highly vulcanized rubber. Carbon black produces no marked alteration in the spectrum of rubber (vulcanized or unvulcanized) other than effects due to scattering. The variation of this scattering with wave length indicates that the size of the carbon aggregate in rubber is of the order of 1μ. Authors

Text. Research J. Mar. 1946

Interaction Between Rubber and Liquids

The interaction between rubber and liquids. VII. The heats and entropies of dilution of natural rubber by various liquids. J. Ferry, Geoffrey Gee, and L. R. G. Treloar. *Trans. Faraday Soc.* **41**, 340–50 (June 1945).

Calorimetric measurements of the heats of mixing of 7 liquids with dihydromyrcene are used to estimate the heats of dilution of rubber by these liquids. Combining the results with free energies calculated from vapor pressure gives entropies of dilution which show significant deviations from the present statistical theory. A thermodynamic study of rubber+methyl alcohol shows similar but larger deviations. Authors

Text. Research J. Mar. 1946

Tensile Strength and Molecular Weight

Tensile strength in relation to molecular weight of high polymers. Paul J. Flory. *J. Am. Chem. Soc.* **67**, 2048–50 (Nov. 1945).

Sookne and Harris have shown that the tensile strength of cellulose acetate depends explicitly on the number-average molecular weight regardless of the molecular weight distribution (*Ind. Eng. Chem.* **37**, 478 (1945); abstract, TEXTILE RESEARCH JOURNAL **15**, 262). A similar dependence of tensile strength on molecular weight (before vulcanization) has been observed for butyl rubber vulcanizates. Vulcanized rubber possesses a network structure; there are no cross-linkages in cellulose acetate. In general, it may be said that tensile strength varies linearly with the reciprocal of the number-average molecular weight at constant degrees of cross-linkage.

A. R. Macormac

Text. Research J. Mar. 1946

Thermodynamics of Mixtures

Statistical thermodynamics of mixtures with zero energies of mixing. E. A. Guggenheim. *Proc. Roy Soc.* **A183**, 203–12 (Nov. 30, 1944).

Earlier work on the derivation of thermodynamic functions for mixtures of 2 types of molecules, one occupying only one site and the other 2 or more, is reviewed. It is shown that the most general equations previously obtained (those for mixtures of molecules occupying one site with molecules occupying any number of sites), which were derived by use of the mathematical technique devised by Bethe for treating order-disorder transitions in alloys, can be derived on a much simpler basis. The present method also has the advantage that it can be generalized to apply to a system containing any number of different types of molecule each with its own geometric properties. Equations for thermodynamic functions of binary mixtures are given in detail, and some sources of inaccuracy in the derivation are discussed. W. E. Davis

Text. Research J. Mar. 1946

Statistical thermodynamics of mixtures with non-zero energies of mixing. E. A. Guggenheim. *Proc. Roy. Soc.* **A183**, 213–27 (Nov. 30, 1944).

The method used in the preceding paper on this subject (*Proc. Roy. Soc.* **A183**, 203 (Nov. 30, 1944)) is extended and modified to apply to mixtures with non-zero energies of mixing. The thermodynamic functions derived here are for the most general case of any number of different types of molecule each occupying a characteristic number of sites, and these are then reduced to the special case of binary mixtures; there is a brief consideration

of the application of the equations to the phenomenon of separation of a mixture into 2 phases. The nature of the approximations used in the derivation is discussed, and it is shown (by making a higher approximation) that the error introduced thereby is small. Finally, a lower approximation is shown to be equivalent to some of the results obtained by earlier workers in this field. W. E. Davis

Text. Research J. Mar. 1946

Water-Vapor Permeability

Measurement of the water vapour permeability of textile fabrics. F. T. Pierce, W. H. Rees, and L. W. Ogden. *J. Text. Inst.* **36**, T169–76 (July 1945).

An apparatus similar to that described in a previous paper (*J. Text. Inst.* **36**, T165–8 (July 1945); abstract, "Surface Evaporation," in *T. R. J.* **16**, 40 (Jan. 1946)) is arranged to keep the fabric dry of liquid water but in contact with a cellulose acetate sheet which is permeable to water vapor. A wide variety of fabrics is investigated and the permeability is roughly correlated with fabric density, except for nylon, which shows an anomalously high resistance. Properly treated fabrics could be made very water-repellent without much loss in vapor permeability with respect to the untreated cloth. However, waterproofing treatments that filled the pores of the cloth increased the resistance to water vapor as well as to liquid water.

Text. Research J. Mar. 1946 G. Halsey

Sorption of Vapors by Wool

Sorption of vapours by keratin and wool. G. King. *Trans. Faraday Soc.* **41** 325–32 (June 1945).

The absorption and desorption rates for water, methyl alcohol, and ethyl alcohol by wool and horn keratin have been investigated for those cases in which diffusion is the rate-controlling process. The results confirm the conception of a diffusion coefficient which increases with concentration, and show that this leads to the building up of a steep front, which advances through the medium as the absorption proceeds. This does not affect the parabolic form of absorption for semi-infinite media but leads to an approximately linear rate in the case of finite media. Author

Text. Research J. Mar. 1946

Degradation of Woolens

The bacterial degradation of woolen felts. C. Binns. *Proc. Tech. Sect., Paper Makers' Assoc. Great Brit. & Ireland* **25**, 280–5 (1944) (through *Bull. Inst. Paper Chem.* **16**, 58 (Oct. 1945)).

After a brief review of previous work, the author states that the purpose of the present investigation was to follow the susceptibility of felts to bacterial decay by the measurements of the tensile strength of woolen yarn after incubation by partial immersion in paper-machine white water under different conditions. It was found that the extent of attack by bacteria is dependent on the water source used in paper manufacture, and is generally increased by the presence of phosphates. Certain modern methods of felt treatment to inhibit attack offer a high order of protection. The intermittent treatment of felts with bactericidal substances is probably effective only if used in relatively high concentrations. Immunity from attack is encouraged by acid conditions. 10 references.

Text. Research J. Mar. 1946

BLEACHING: DYEING FINISHING

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Carboxymethylcellulose

Carboxymethylcellulose—uses and applications. C. B. Hollabaugh, L. H. Burt, and A. P. Welsh. *Ind. Eng. Chem.* **37**, 943–7 (Oct. 1945).

Commercial usage of carboxymethylcellulose, usually in the form of its sodium salt, has increased rapidly in recent years. This product is a cellulose derivative formed by the reaction of monochloroacetic acid on alkali cellulose. The sodium salt is readily soluble or dispersible in water to form viscous solutions. Such solutions are utilized for their thickening properties, to aid in the suspension of pigments and other finely divided solids in liquid media, and to stabilize emulsions of various types. This article discusses briefly and gives references to most of the published literature, but with no effort to evaluate the many and varied suggestions. Most of the references in the appended bibliography show publication dates of recent years. 94 references.

Text. Research J. Mar. 1946 Authors

Crease-Resistant Finishes

Crease-resistant finishes. A. R. Wachter. *Am. Dyestuff Reptr.* **34**, P464–5 (Nov. 19, 1945).

A tour of English plants finishing rayon fabrics with urea-formaldehyde or melamine-formaldehyde resins was made to determine the reason for the superiority of the English resin-finished fabrics to those produced in this country. The most generally employed mechanical routings of resin-processed rayon fabrics in English plants are described. When ammonium dihydrogen phosphate is used as a catalyst, the goods are given full immersion in a deep resin bath and allowed to travel at least $1\frac{1}{2}$ yds. before any nip pressure is given in order to provide good penetration and absorption; when boro-tartaric acid is employed, stability of the mix is only about 7 min. and very shallow baths must be used. Drying at all stages is of extreme importance and generally accomplished on fully housed overfeed pin tenter-type frames producing no tension; specially constructed curing ovens assure absolutely no fabric agitation and a cloth temperature of 300° F with no moisture whatever in the circulator. Nowhere are rayon fabrics which are being processed batched or rolled until ready for shipment to the customer.

K. S. Campbell

Text. Research J. Mar. 1946

Fabric Finishing

Post-war possibilities in finishing fabrics. H. C. Borghetty. *Am.*

Dyestuff Reptr. **34**, P364–6 (Sept. 10, 1945).

New developments and probable future trends in fabric finishes are discussed. Emphasis in all classes is definitely on the permanent type of finish. K. S. Campbell

Text. Research J. Mar. 1946

Plastics

Plastics in the textile industry. P. T. Gayle. *Textile Weekly* **36**, 1082, 1084, 1086, 1128, 1130, 1132 (Dec. 7 and Dec. 14, 1945).

A discussion of the use of plastics in the finishing of fabrics woven or knitted from synthetic fibers as well as from natural fibers. The finishing of wool, cotton, rayon, and nylon fabrics is explained.

H. J. Burnham

Text. Research J. Mar. 1946

Dry Processing

Machines for dry processing. Anon. *Text. Recorder* **62**, 49–51, 63 (Sept. 1945).

A brief survey of the machines employed for dry processing of fabrics is presented. As most fibers are plasticized by moisture, the fabrics are conditioned before dry finishing. The conditioning machines described and illustrated are: Sjostrom conditioner, brush damper, and 2 types of spray damping machines. After conditioning the cloth is finished by mangling, belt stretching, calendering, beetling and/or tamponing. 15 diagrams and figures illustrate the different machines discussed.

A. L. Merrifield

Text. Research J. Mar. 1946

Pad-Steam Process

The pad-steam continuous dyeing process. Anon. *Silk J. Rayon World* **21**, 35–6, 38 (Oct. 1945).

Steam is employed as the fixing agent in the new continuous process described, whereby the full range of vat colors may be applied in pastel to very deep shades to a wide variety of fabrics. Color reduction and fixation are effected in a matter of seconds. Choice between the basic pad-steam and alternative methods involving liquid boosters in the steam chamber will be determined by specific mill conditions.

R. K. Worner

Text. Research J. Mar. 1946

Wet Processing

Machines for wet processing. Anon. *Text. Recorder* **62**, 49–51, 67 (July 1945).

A short survey is presented of the machines used for the wet finishing processes for material from animal and vegetable fibers. Wet finishing processes for woolen fabrics are concerned with the permanent set of wool and with its ability to contract and consolidate on milling; however, cotton fabrics do not acquire a permanent set nor can they be milled, but cotton is plastic when wet and may be mangled to give a smooth sheer appearance as a foundation for the impregnation processes with common finishing preparations. 24 diagrams and cuts are given of machines employed in the above processes for finishing wool and cotton fabrics.

A. L. Merrifield

Text. Research J. Mar. 1946

Wet Processing in Germany

Wet processing in Germany. F. S. Richardson. *Am. Dyestuff Reptr.* **34**, P463, 466 (Nov. 19, 1945).

Wet finishing methods in general use for textiles in Germany are briefly described. An interesting process still in the experimental stage is the ageing of printed fabric by passage through a bath of molten tin and bismuth, the printed portions of the cloth containing sufficient moisture to produce enough steam to age the print completely.

K. S. Campbell

Text. Research J. Mar. 1946

Resins for Textiles

Resins for textiles. J. E. Lynn. *Am. Dyestuff Reptr.* **34**, 506–7, 510 (Dec. 3, 1945).

The present status of resins for impregnation of textiles is surveyed. Of the thermosetting variety urea-formaldehyde and melamine-formaldehyde are by far the most widely used; both impart crease-resistance and shrinkage control to cottons and dimensional stability to synthetics; the latter absorbs chlorine from bleach liquors and will become yellow but does not react with it (to form hydrochloric acid as does urea-formaldehyde) and undergo tendering in subsequent treatment. Both resins cause a lowering of tensile strength and decrease abrasion resistance in cotton goods. Partially or completely polymerized thermosetting resins in the form of solvent solutions or emulsions provide special finishes as for fullness, pigment binding, etc., but do not produce crease-resistance. In general the higher the initial degree of polymerization of the impregnant, the lower the wash-fastness. Thermoplastic resins, notably the various vinyl compounds and acrylic acid derivatives, give an increased abrasion resistance and do not lower tensile strength, but provide neither shrinkage control nor crease-resistance. Their main function is usually to impart a desired wash-resistant soft or stiff handle.

K. S. Campbell

Text. Research J. Mar. 1946

Rotproofing of Canvas

Rotproofing of canvas. Preliminary report on experiments carried out in 1944–45. R. M. Brien and Joan M. Dingley. *New Zealand J. Sci. and Tech.* **27**, 133–8 (Sept. 1945).

A series of investigations was conducted in order to establish a suitable technique for testing therapeutants used for protecting canvas, cordage, etc., against fabric-rotting fungi. Isolations from specimens of rotted canvas yielded a number of common mould fungi. From these, *Stachybotrys atra* Corda, an active cellulose-destroying fungus, was selected as the most suitable test organism for the experiments. A technique was evolved by which treated strips of canvas, both before and after leaching, were inoculated with *S. atra* and held for 3–4 weeks under optimum conditions of tem-

perature and moisture for growth of the test fungus. 7 chemicals were tested by the above technique for their efficiency as rotproofing agents. Results of experiments are expressed as tensile breaking load of test canvases in pounds.

Text. Research J. Mar. 1946 Authors

Sizing Spun Rayon

Sizing of spun rayon yarn: Methods of application. Anon. *Silk and Rayon* **19**, 989, 997 (Sept. 1945).

A brief discussion of the sizing of spun rayon yarn. The terms of the sizing problem are (1) to obtain controlled and level application of the size to the yarn and (2) to ensure complete and even removal of size before finishing. Some of the main factors are: (1) viscosity of the size; (2) speed of machine; (3) type of warp; (4) twist factor of warp; and (5) care of slashing machine. It should be borne in mind that unconverted starches easily become occluded, or form insoluble films in the presence of metallic salts and under the influence of heat. This may possibly account for some of the dyeing and finishing difficulties.

A. L. Merrifield

Text. Research J. Mar. 1946

Urea Derivatives for Textiles

Urea derivatives instead of urea for textile treatment. Anon. *Silk and Rayon* **19**, 922–3, 998, 1000 (Sept. 1945).

The first of a series of articles on synthetic substances such as urea, guanidine and melamine. A brief outline is given of the manufacture of urea, biuret, cyanuric acid, melamine, guanidine and biguanide. Certain guanidine and aminoguanidine salts may be employed for modifying the hand and dyeing properties of cellulose fibers and are fixed in the fiber with the aid of formaldehyde so that a water-insoluble compound is formed which can be set with heat. In treatment with guanidine salts, it is probable that the softening effect is due to the presence of the long-chain aliphatic residue, while the wool dyeing properties are due to the presence of the basic guanidine residue. It is also possible to effect the dyeing of wool with these salts, giving it an affinity for cotton dyes. Salts of guanidine and biguanide can be made which increase fastness of dyes and used as levelling and stripping agents for vat dyes. The preparation and application to fabrics of several of the salts of guanidine and biguanide are presented in detail. A. L. Merrifield

Text. Research J. Mar. 1946

Gum Tragacanth

Gum tragacanth in textile printing. Anon. *Text. Recorder* **62**, 52–3 (Sept. 1945).

A brief history and discussion of the use of gum tragacanth in textile printing is presented. Its advantages are: (1) high thickening power per gal. of water; (2) ease of removability; (3) ability to stand up to alkali; (4) good miscibility with almost any other type of thickener derived from starch; (5) powers of suspension where finely divided pigments are used in print paste; (6) powers of penetration; (7) good keeping qualities, does not sour readily; and (8) high color yield when printing deep shades with a minimum concentration of dyestuff. A. L. Merrifield

Text. Research J. Mar. 1946

Utilization of Kier Waste

The kier waste liquor. A. M. Patel. *Indian Textile J.* **55**, 622–4 (June 1945).

The use of kier waste liquor as a leveling agent is described. It was found to be as effective as the usual level dyeing auxiliaries. No difficulties were encountered even with colors having a reputation for misbehaving, provided sufficient dosage was used. It is advisable to employ liquors produced by boiling out grey goods with 2–3% caustic soda and other scouring agents such as soda ash, soap, and turkey red oil, either in open or closed kiers for a period of at least 10 hrs.

R. K. Worner

Text. Research J. Mar. 1946

Papain

The potentialities of papain in the textile industry. J. Wakelin. *Am. Dyestuff Reptr.* **34**, 371–2 (Sept. 10, 1945).

Papain, a proteolytic enzyme in the form of the dried juice of the papaya tree, may be used for stripping albumen-fixed pigment colors, for degumming silk, to produce non-felting wool, and to improve the appearance and handle of chlorinated wool. Sodium thiosulfate or hydrosulfite is generally employed to "activate" the papain.

K. S. Campbell

Text. Research J. Mar. 1946

Rayon Processing

Rayon dyeing and finishing developments. W. F. Brosnan. *Am. Dyestuff Reptr.* **34**, 491–2, 509–10 (Dec. 3, 1945).

A descriptive review covering highlights of the most recent methods of preparing, bleaching, dyeing, printing, drying, and finishing of viscose, acetate rayon, nylon, and blended fabrics. K. S. Campbell

Text. Research J. Mar. 1946

Silk Nets

The processing of real silk net materials. Anon. *Silk and Rayon* **19**, 877, 883 (Aug. 1945).

A review of the finishing of real silk net materials is given. The type of tenter, method of fixing the net to the frame, application of finishing solutions, use of enzyme degraded starch compositions for stiffening and the addition of a small percentage of a resin such as a near condensed urea-formaldehyde are discussed. The finish employed and the number of coats applied to the net, however, vary according to the ultimate use. A. L. Merrifield

Text. Research J. Mar. 1946

Preparation of silk net materials for finishing. Anon. *Silk and Rayon* **19**, 781–2 (July 1945).

An outline of the preparation of silk net materials for finishing is presented including removal of graph-

ite stains, de-gumming, bleaching, and dyeing. Particular attention is given to bleaching and it is recommended that the peroxide solution has a pH of 9, and sodium silicate be employed as the alkali. Sodium silicate acts as a stabilizer retarding the formation of oxygen gas from the peroxide increasing its usefulness. Oxalates have also been found useful for this purpose. A hand winch is preferred when dyeing this easily damaged material. A. L. Merrifield

Text. Research J. Mar. 1946

Vat Dyeing

Dyeing of vat colors without hydrosulfite. S. M. Nanal. *Indian Text. J.* **55**, 893 (Sept. 1945).

The use of mohwa flowers extract for vat dyeing with reduced colors such as Ind Violet RR, Caledon Brill Purple 800 pdr., and Caledon Jade Green B is described. Glucose, gur, and molasses are also used in dyeing with vat colors.

R. K. Worner

Text. Research J. Mar. 1946

Wool Dyeing

Theory and practice of wool dyeing. XXI. Machines for dyeing hose, felt hats, and garments. C. L. Bird. *Text. Recorder* **62**, 53–4 (July 1945).

The machines employed for dyeing hose, felt hats, and garments are essentially the same and the following 3 types are described: (1) oval paddle, (2) overhead paddle, and (3) the Cassé hat dyeing machine.

A. L. Merrifield

Text. Research J. Mar. 1946

pH Control in Wool Dyeing

pH control in dyeing processes. E. I. Noble. *Am. Dyestuff Reptr.* **34**, 359–62, 367–70 (Sept. 10, 1945).

Utilization in wool dyeing of the buffering action of phosphoric acid and phosphates is described and the mechanism involved is explained. Many practical examples are given. K. S. Campbell

Text. Research J. Mar. 1946

Printing Woolens

The printing of woolens. W. D. Baird. *Am. Dyestuff Reptr.* **34**, 508–9 (Dec. 3, 1945).

A technical survey of wool printing, including approved methods for preparing (singeing, scouring, bleaching, chloring) the cloth and for printing with basic, chrome, acid, and direct colors. Selected lists of dyes in each group are given. It is stated that preliminary chlorination of the material is practically a necessity for printing deep shades on woolen fabrics. K. S. Campbell

Text. Research J. Mar. 1946

Reconversion in Dyestuff Industry

Reconversion of the dyestuff industry. H. F. Herrmann. *Am. Dyestuff Reptr.* **34**, 493–510 (Dec. 3, 1945).

Only 3% of the dyestuffs used in this country were imported before the war began; absence of foreign dyestuffs therefore has not caused inferior fastness properties in American fabrics. There is no such thing as the manufacture of a given dyestuff in sub-standard quality. Presence on the market of goods of unsatisfactory dye fastness may be explained by the fact that Conservation Order M-103 allowed each finishing plant a quota of dyes, other than anthraquinone derivatives, based upon the amount of money spent during the base period, leaving a choice as to whether it should be spent for good dyes or a larger amount of cheap dyes. No radical developments in postwar reconversion of the dyestuff industry is expected; new dyes brought out as opportunity permits will in many cases be duplicates of those formerly imported. K. S. Campbell

Text. Research J. Mar. 1946

Dyeing Instruction in High Schools

Dyes and dyeing for beginners. Charles H. Stone. *J. Chem. Ed.* **22**, 380, 386 (Aug. 1945).

Projects, such as the preparation of simple dyes and their application to the appropriate textile materials, are suggested for arousing high-school students' interest in dyes and dyeing. Directions are given for preparing and applying Orange II, Fast Red, Bismarck Brown, Chrysamine, Indigo, and Alkali Blue. R. K. Worner

Text. Research J. Mar. 1946

FIBERS: YARNS: FABRICS: MECHANICAL PROCESSES

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Alginate Fibers

Alginate "rayons" are distinctive new fibers. P. Ripley. *Textile World* **95**, 112–13 (Dec. 1945).

Various types of alginate fibers and methods of manufacture are discussed. Alginic acid is extracted from metallic salts of the acid. Fibers are non-inflammable and those of calcium are said to be easy to weave. A yarn strength of 2 g. per den. per filament is given. Development is still in the research stage. Properties of alginic acid, and the alginates of calcium, aluminum, chromium, and beryllium are tabulated. H. J. Burnham

Text. Research J. Mar. 1946

Flax Manufacture

Making flax fibers into yarns. E. Ostlick. *Fibres* **6**, 117–19 (Oct. 1945).

In 1939, the U.S.S.R.'s production of 550,000 tons of flax comprised nearly 80% of the world production, but fiber flax is also an important crop in Poland, France, Ireland, Germany, and Italy. Flax-pulling machines are replacing hand methods of harvesting flax, which is pulled instead of cut to prevent lowering the spinning value of the fibers. The retting process has been speeded up during recent years by use of chemicals in the retting bath and by increasing its temperature so as to increase bacterial action; as a result the retting period

has been reduced from 10–12 days to 2 or 3 days. After scutching and hackling, the long "line" fibers are spun either wet or dry. Wet spinning, which is practiced principally in Ireland, is particularly suitable for very fine yarns, since the wetting enables the fibers to slip by each other more readily as rollers draw them out. Dry spinning, which is customary in Scotland, is used for coarser yarns. Flax acreage in Great Britain and Northern Ireland increased from 26,000 acres in 1929 to 161,000 acres in 1944.

Text. Research J. Mar. 1946 R. B. Evans

Parachute Manufacture

Technicalities of parachute manufacture in India. K. N. Tiku. *Indian Textile J.* **55**, 625–6 (June 1945).

Practical details are given for making silk parachute cloth, including preparation of yarn and loom specifications.

R. K. Worner

Text. Research J. Mar. 1946

Protein Fibers

The molecular structure and properties of textile fibers—protein fibers. J. P. DeSouza. *Indian Text. J.* **55**, 806–7 (Aug. 1945).

Wool, silk, and the protein manufactured fibers are discussed briefly.

R. K. Worner

Text. Research J. Mar. 1946

Chemistry of Wool

Some chemical aspects of wool protein behavior. K. S. LaFleur. *Am. Dyestuff Reptr.* **34**, 395–8, 407–14 (Oct. 8, 1945).

The essential concepts of wool protein chemistry are presented for the purpose of establishing a basis for a better understanding of the chemical reactions of the wool fiber. Some of the fundamentals discussed are: chemical structure of amino acids; the polypeptide hypothesis; additional linkages in wool protein; wool hydrolysis; molecular weight of wool; potentially reactive groups in wool; dissociation of amino acids; dissociation curves for the dibasic and diacid amino acids found in wool; dissociation diagram of wool (i.e., a composite picture of the dissociation of wool as an acid and a base); isoelectric points.

K. S. Campbell

Text. Research J. Mar. 1946

"Tender" Wools

Growth changes in "tender" wools. W. R. Lang. *J. Text. Inst.* **36**, T243–52 (Oct. 1945).

Information has been sought concerning the response in the thickness factor in the fibers composing a staple, in which a "tender" region occurs when the volume-rate of wool production decreases rapidly, and again when the volume-rate is re-established at approximately its original level. Microscopical evidence shows that the majority of fibers ceasing growth do so by expulsion of the terminal or root bulb from the follicle. Fiber thickness measurements reveal a differential follicular response in certain wools, particularly in those with a marked difference between the coarser and finer fibers. As the volume-rate of production decreases, the coarser group may suffer little change in thickness, whereas the finer bulk undergoes considerable change. In wools with a nearly normal type of frequency distribution, all fibers appear to suffer similar decrements in fiber cross-section in the majority of cases examined. As the volume-rate is again increased, frequency distributions suggest that in most examples the reverse response is usual—i.e., the fine bulk regains its former mean thickness, while the coarse fibers remain comparatively unaffected. In near normal types of distribution all fibers respond in a similar degree.

Text. Research J. Mar. 1946 Author

Yarn Conditioning

Modern yarn conditioning. Anon. *Text. Recorder* **62**, 39–41 (Sept. 1945).

A brief discussion of yarn conditioning appliances for cops, ring bobbins, cones and cheeses is presented. These machines may be either of permanent or of portable construction. One cop or bobbin machine is claimed to be capable of conditioning 50,000 lbs. of yarn per 48-hr. week and a cone machine to have the capacity of 500 cones per hr. per operation. The main advantages of these conditioning appliances are: known amount of liquid applied, low space consumption, and reduced labor. A. L. Merrifield

Text. Research J. Mar. 1946

British Textile Developments

Recent textile developments in Britain. A. J. Hall. *Am. Dyestuff Reptr.* **34**, 494–6 (Dec. 3, 1945).

A review of new materials and methods in the British textile industry. These include: use of non-felting wool, wider use of protein fibers (such as Ardil, made from peanut protein), high-tenacity rayons, specialty fibers such as glass and polymerized ethylene (polythene) fibers, synthetic resin finishes, and new finishing machinery.

K. S. Campbell

Text. Research J. Mar. 1946

Fraying of Textiles

Fraying and slippage in woven textiles. Anon. *Text. Recorder* **62**, 43–4, 49 (Aug. 1945).

The faults known as "fraying" and "slippage" in the processing of woven textiles are common and are chiefly found among loosely woven fabrics. A discussion of fraying and slippage is given from the point of view of sizing, weaving, scouring, bleaching, crepeing, dulling, dyeing, printing, and finishing of the fabric. The tendency to fray is due principally to cloth construction, faulty sizing, working conditions, and excess tension at any stage during processing. A. L. Merrifield

Text. Research J. Mar. 1946

Flax Carding

Efficiency in flax tow carding. Anon. *Text. Recorder* **62**, 44–6 (Sept. 1945).

The variable nature of flax material to be carded, and the wide range of

yarn qualities required do not permit standardization of speeds for various cards details; the following general rules may be used as a guide: (1) for coarse, strong tows of a dirty nature the cylinder should be run at a high speed, the stripper at a medium speed, and the workers should be run slowly; (2) for strong tows of an open, clean nature the cylinder may be run at a high speed and strippers and workers at low speed; (3) for soft tows of a dirty nature—medium cylinder, fast strippers and workers; and (4) for soft tows of a clean nature—medium cylinder, a medium stripper speed, and a high speed for the workers will give the best results.

A. L. Merrifield

Text. Research J. Mar. 1946

High-Speed Winder

The automatic winding of warping cones and cheeses. Anon. *Text. Recorder* **62**, 46–8 (July 1945).

An American automatic winding machine for warping cones and cheeses known as model U is described. The operation, number of spindles per machine, mechanical construction, and comparison with other winders are presented. The 2 main factors necessary to make automatic winding ideal are reasonable weights of any one count or denier and reasonably good yarn. It is claimed that the operative production per hour with 2-oz. bobbins would be 106 lbs. per hr. or 5,000 lbs. per 48 hr. week as against 1,800 lbs. per 48 hr. week for other types of winders.

A. L. Merrifield

Text. Research J. Mar. 1946

Winders and Warpers

New high-speed winding and warping machinery. Anon. *Text. Recorder* **62**, 52–3 (Aug. 1945).

A new high-speed cone and cheese winder, claimed to have a production capacity of 26 lbs. per spindle for a 48-hr. week when winding 80s cotton yarn at 750 y.p.m., is described. A beaming machine which has a drum that can be expanded laterally from 54 to 63 in. in width and a remote control device to lift the full beam from the machine onto a truck is also presented. A. L. Merrifield

Text. Research J. Mar. 1946

Dobby Loom

A positive dobby and its operation. Anon. *Text. Recorder* **62**, 38–40, 58 (Aug. 1945).

The fourth of a series. The following settings for the heald and box motions of the positive dobby are described and illustrated by cuts of various parts: (1) the eccentric head drive, sley, handwheel, bevel gears, and heald cylinder gears; (2) the heald section, cylinder gears, chain shaft, top cylinder, bottom cylinder, and time-forward and reverse; (3) the lock knife; (4) the upright shaft gears, time of heald crossing in relation to the position of the sley, the dwell motion, and round driving gears; (5) vibrator replacement; and (6) the box section and adjustment of a 4-cell drop box. A. L. Merrifield

Text. Research J. Mar. 1946

High-Speed Smallware Loom

High-speed smallware loom. Anon. *Text. Recorder* **62**, 47–8 (Sept. 1945).

A high-speed smallware 100 with the following features is presented: high output; variety of manufacture due to independent heads; automatic warp and filling stop motions, each of which may be individually controlled; directly and positively driven picking motion; regulator for changing the number of picks per in. without changing gears; and small floor space. It is claimed that one girl can operate from 9–24 looms running at speeds as high as 300 picks per min. A. L. Merrifield

Text. Research J. Mar. 1946

Linen Looms

Meeting modern needs for weaving linen. Anon. *Text. Recorder* **62**, 43–5 (July 1945).

A description is given of 2 new looms with 180 picks per min. for plain linen textiles, built on modern lines, and changes in the following features: motor drive, reed space and beat-up, inside shaft tappets, suspension of take-up motion, shuttle boxes, cloth winding and safety devices. A. L. Merrifield

Text. Research J. Mar. 1946

MISCELLANEOUS

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Reports of German Research *

Special protective garment for aviators (Seenotschutzgerat). Jean G. Kern and others. U. S. Department of Commerce, Office of Publication Board. Report PB 196, 1945; 7 pp.; mimeo., 10¢ (through *Bib. Sci. and Ind. Reports* **1**, 1 (Jan. 11, 1946)).

Description of a garment designed to protect aviators and navy personnel against freezing in cold ocean water. The garment was developed by Prof. Mecheels; it consisted of 3 layers and contained a special powder in the middle layer, which was to form a protective foam upon contact with salt water. The powder consisted of 24.4% Mersolat H-30 &, 41.46% $NaHCO_3$, and 34.14% citric acid. Composition of another less effective powder is also given: 24.4% Igepon AP extra conc. &, 30.9% $NaHCO_3$ and 44.7% Benzoic acid. Preparation of Mersolat H-30 and Igepon AP extra conc. is outlined in the appendix. A person equipped

* These are reports of the various observers who have visited industrial plants in Germany. They are issued by the U. S. Department of Commerce, Office of the Publication Board, Washington 25, D.C. Copies of the original reports may be obtained from that office.

The *Bibliography of Scientific and Industrial Reports* is a weekly publication devoted to abstracts of these reports. As soon as the reports appear they are abstracted in the *Bibliography*. Such of these abstracts as are of interest in the field of textiles will be reprinted from time to time in TEXTILE RESEARCH JOURNAL.

Subscriptions to the *Bibliography of Scientific and Industrial Reports* may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D.C.

with the garment can exist in 0°C water for 3 hrs. or more.
Text. Research J. Mar. 1946

I. G. plastics activity. L. J. Bellamy, K. T. Nilsson, and J. W. Haught. U. S. Department of Commerce, Office of Publication Board, Report PB 8, 1945; 3 pp.; mimeo., 10¢ (through *Bib. Sci. and Ind. Reports* **1**, 1 (Jan. 11, 1946)).

Information is given on the work of the I. G. Plastics Laboratory on the manufacture of plastics and their use. The following subjects are covered: polyvinyl acetate, polyacrylic esters, polystyrene, polyvinyl chloride, chlorinated polyvinyl chloride, igamide (nylon), polyethylene (lupolene), vinylidene chloride polymer, melamine resins, and urea resins.
Text. Research J. Mar. 1946

Chemische Werke Albert Biebrick, near Wiesbaden. V. V. Bidlack. U. S. Department of Commerce, Office of Publication Board, Report PB 389, 1945; 6 pp.; photostat, $1.00—microfilm, 50¢ (through *Bib. Sci. and Ind. Reports* **1**, 2 (Jan. 11, 1946)).

This report deals with resin coatings made by this plant. The coatings are chiefly phenolic resins in suitable solvents. A number of these are described.
Text. Research J. Mar. 1946

I. G. Farbenindustrie A. G., Mainkur Works, Fechenheim. R. W. Sudhoff. U. S. Department of Commerce, Office of Publication Board, Report PB 203, 1945; 9 pp.; mimeo., 10¢ (through *Bib. Sci. and Ind. Reports* **1**, 10 (Jan. 11, 1946)).

Report of visit to plant of I. G. Farbenindustrie. Primarily a dyestuffs plant though recently considerable efforts have been made in the manufacture of intermediates for plastics and resins. Among the processes briefly described are those for producing Melamine or Azamine E, Maprenal MJB, Benzoguanamine, Maprenal BG, Kaurit MKF (used as a treating agent for rayon), and phenothiazine.
Text. Research J. Mar. 1946

Fabrication of plastics, I. G. Farbenindustrie, Wolfen. Miscellaneous chemicals—methods used to fabricate plastics. R. H. Boundy and R. L. Hasche. U. S. Department of Commerce, Office of Publication Board, Report PB 400, 1945; 10 pp.; mimeo., 10¢ (through *Bib. Sci. and Ind. Reports* **1**, 29 (Jan. 18, 1946)).

Visit in May, 1945, to German plant for purpose of obtaining information on methods used to fabricate plastics. Chief products were polyvinyl chloride monofilament and fine fiber, nylon film and fibers, and cellulose acetate and mixed ester films. Brief descriptions of processes for making polyvinal chloride monofil and fine fibers, and also of caprolactam spinning. Several diagrams are included for the latter process.
Text. Research J. Mar. 1946

Glossary of some German names for chemical products. Harry A. Curtis. U. S. Department of Commerce, Office of Publication Board, Report PB 475, 1945; 25 pp.; photostat, $2.00—microfilm, 50¢ (through *Bib. Sci. and Ind. Reports* **1**, 30 (Jan. 18, 1946)).

An alphabetical list of German names for chemical products. Names taken largely from a quarterly record of I. G. Farbenindustrie listing all new chemical compounds or new chemical products made. Period covered is from 1935 to 1944, inclusive. Not a complete list but a selection of some that may be found useful to readers of chemical record from I. G. and other German sources. Glossary contains, for the most part, I. G. names for materials that are actually or potentially of industrial importance.
Text. Research J. Mar. 1946

German sewing thread industry. Herbert F. Schiefer and Richard T. Kropf. U. S. Department of Commerce, Office of Publication Board, Report PB 1026, 1945; 5 pp.; mimeo., 10¢ (through *Bib. Sci. and Ind. Reports* **1**, 61 (Jan. 18, 1946)).

The German sewing thread industry produced a total of approximately 8,000,000 kg. of thread products per year amounting to an annual sales of approximately 100,000,000 marks. During the war, the production and sales were approximately 150% of normal. Normally the products consisted of sewing threads, darning threads, and art needle threads (knitting, crochet, and embroidery, etc.) produced from cotton, linen, silk, and rayon. During the war cotton was cut off and threads were made primarily from spun rayon (high strength staple) and from high strength rayon as well as smaller quantities of linen and silk. The production methods and equipment used throughout the industry are quite conventional, and follow the usual designs. The distribution and sales of the industry are handled primarily by Sales Syndicates. It is estimated that these Syndicates handle 90% of the German thread business. The German thread industry has not sponsored fundamental or applied research. When such work has been required, as in the case of spun rayon threads, it has been referred to outside organizations.
Text. Research J. Mar. 1946

Recent British Textile Patents

This month's progress in rayon and synthetic fibers. Anon. *Silk and Rayon* **19**, 757–60 (July 1945).

A brief discussion of the following subjects is given: (1) production of crepe acetate rayon fabrics (B.P. 567,310); (2) processes for improving ropes with cellulose ethers (B.P. 567,338); (3) method of making transparent films with polyamides (B.P. 568,044); (4) metal-salt-alcohol solutions capable of dissolving polyamides and interpolyamides (B.P. 563,078); (5) apparatus for making nylon films (B.P. 567,358); (6) hardening processes for casein rayon (B.P. 567,904); (7) spinning of alginate rayon filaments (B.P. 568,177); and (8) dyeing of Vinyon (B.P. 568,037).

A. L. Merrifield
Text. Research J. Mar. 1946

This month's progress in rayon and synthetic fibers. Anon. *Silk*

and Rayon **19**, 873–5, 890 (Aug. 1945).

A brief discussion of the following subjects is given: (1) method of spinning fibers from molten products (B.P. 565,489); (2) manufacture of aliphatic dibasic acids (B.P. 565,-636); (3) the fluidity of degraded nylon in formic acid and meta-cresol; (4) factors which affect the tensile strength of casein rayon; and (5) printing acid dyes on viscose rayon. A. L. Merrifield

Text. Research J. Mar. 1946

Progress in rayons and textile auxiliaries. Anon. *Silk and Rayon* **19**, 981–3, 1005 (Sept. 1945).

A brief discussion is given of the following subjects: (1) producing low lustre acetate rayon materials dyed in tertiary shades (B.P. 568,-433); (2) the manufacture of cellulose acetate-formate (B.P. 568,439); (3) manufacture of nylon with improved dyeing properties, softness and pliability (B.P. 568,977); (4) aspects of the processing of nylon yarn; (5) manufacture of alginate fibers (B.P. 569,212); and (6) prevention of orifice blockage in spinning (B.P. 568,729). A. L. Merrifield

Text. Research J. Mar. 1946

Fiber Testing

Tests show best cotton for a specific purpose. Anon. *Textile World* **95**, 99 (Dec. 1945).

An address by W. O. Jelleme of Pacific Mills. Fiber tests are recommended as the basis for specifying cotton purchasing. Various tests are mentioned briefly. H. J. Burnham

Text. Research J. Mar. 1946

Polish Textile Industry

A brief review of the Polish textile industry. L. G. Manitius. *J. Text. Inst.* **36**, P158 (Oct. 1945).

A short history is given, together with statistics showing the extent of the textile industry in Poland before World War II. A brief review of manufacturing methods in Polish cotton mills is included. J.

Text. Research J. Mar. 1946

Progress in Textile Industry

Review of current textile progress. A. J. Hall. *Am. Dyestuff Reptr.* **34**, 385–8 (Sept. 24, 1945).

The following subjects are reviewed in some detail: mothproofing of furs by a new process employing saturated sodium chloride plus formaldehyde and hydrochloric acid; the use of a special extraction technique to simplify the production of higher fatty acid esters of cellulose in pure form; improved methods for differentiating gelatins or glues; dyeing of the newer synthetic fibers; and the production of increased wear and resistance to laddering in ladies' rayon hose by treatment with a liquor in which resins are present in the form of relatively coarse particles. K. S. Campbell

Text. Research J. Mar. 1946

Labor in the British Cotton Industry

Labor in the cotton industry. Cotton Board Conference. *Text. Recorder* **62**, 55–64 (July 1945).

The main theme of the British Cotton Board's Recruitment and Training Department Conference was "Labor in the Cotton Industry." Abstracts of 7 of the addresses presented at the conference are given. The subjects and speakers are as follows: labor in the cotton industry, Sir Raymond Streat; educating the young worker, Sir Robert S. Wood; employee services in the small firm, Miss Beryl Foyle; health in the mill, Dr. Robert Sutherland; the development of joint consultation, Miss Dorothy Elliott; people and production, W. Hodgkins; and the international labor office, C. Robbins. A. L. Merrifield

Text. Research J. Mar. 1946

Training Service

Cotton fiber technician training service. Anon. *Textile Bulletin* **69**, 18, 44 (Dec. 1, 1945).

A description of the training service offered by the Cotton Textile Institute and Clemson College in training mill laboratory personnel in the techniques of cotton fiber testing. An 8–10 weeks' course covers fiber strength measurements (both round and flat bundle), maturity tests, fiber length and length distribution with the Suter-Webb sorter, fiber length analysis with the Hertel fibrograph, and fiber fineness tests by the weight-per-in. method. No charge is made for the training program and arrangements for room and board can be made at a cost of approximately $125.00 for the 8-week period. H. J. Burnham

Text. Research J. Mar. 1946

Western Regional Laboratory

The U. S. Department of Agriculture's Western Regional Research Laboratory. W. B. Van Arsdel. *Paper Trade J.* **120**, 34–7 (June 7, 1945).

The Regional Research Laboratories were created by an Act of Congress in 1938 to conduct research and development work for the purpose of extending the markets for farm commodities. Laboratories were established in the Eastern, Western, Northern, and Southern regions of the United States, which, in general, specialize in the special interests of the region involved. Their constitution and activities are described, with particular reference to the work of the Western laboratory. Author

Text. Research J. Mar. 1946

PATENT REFERENCES

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Drafting Mechanism

Drafting mechanism for textile fibers. Joseph Noguera (to Casablancas High Draft Co., Ltd.). U. S. 2,388,760 (Nov. 13, 1945).

Improved drafting mechanism for fibers.

Text. Research J. Mar. 1946

Pile Fabric

Production of pile fabrics. Thomas Arthur Brown (to Brown, Ogden & Co., Ltd.). U. S. 2,388,465 (Nov. 6, 1945).

Novel means for the production of pile fabrics by passing a web of

loose fibers past a row of parallel metal plates set edgewise and pricking the fibers between the plates so that they form a U around the edges of the plates. A means for sewing the U strips to a backing is provided.
Text. Research J. Mar. 1946

Specialty Fabric

Production of novel fabric. Howard L. Shuttleworth (to Mohawk Carpet Mills, Inc.). U. S. 2,389,-091 (Nov. 13, 1945).

This invention relates to a low-cost floor covering for bedrooms and for bathroom mats, and a special loom with which to produce the fabric. The fabric is composed of heavy weft yarns with a face and back system that is interchangeable. There is one system of warp threads which acts as a binder. In addition there are a series of warp wires that are anchored in place and controlled by heddle eyes; these wires are used as a means of separating face filling from back filling at desired intervals. The loom uses a Jacquard-type head motion with a trap board and also uses a needle similar to the Axminster loom for inserting the filling. A selective device enables the needle to insert first one colored filling and then another colored filling. The Jacquard head controls the heddle eyes to which the warp wires are attached and in the accustomed way creates a figured pattern by raising or staying at the bottom of the shed as each filling is inserted. P. T. I.
Text. Research J. Mar. 1946

Garnetts

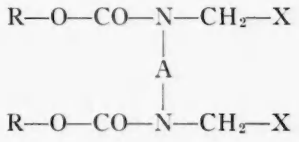
Garnett clothing. William F. Bokum (to Proctor & Schwartz, Inc.). U. S. 2,388,631 (Nov. 6, 1945).

According to this invention ordinary Garnett wire is cut into equal lengths each approximately equal to the circumference of the cylinder or roll to be covered. One end of each strip is welded to an end of another strip so that the wire can be wound on the roll in the usual manner but with this difference—the wire will be in parallel rings instead of the usual spiral, the object being to permit automatic "stripping" or cleaning of the clothing.
Text. Research J. Mar. 1946

Impregnating Treatments

Process of treating textile materials. Maurice A. T. Rogers (to Imperial Chemical Industries, Ltd.). U. S. 2,386,141 and 2,386,143 (Oct. 2, 1945).

A modification of U. S. Patent 2,386,140, in the formation of a quaternary ammonium compound which can be impregnated in textile materials, giving combined softness and water-repellency. The new halogenomethyl compound has the general formula:



wherein R is an aliphatic radical of at least 7 carbon atoms, X is a halogen, and A is a divalent organic radical, and the compound reacts with aliphatic or heterocyclic tertiary amine. These halogenomethyl compounds are derivatives of fatty alcohols. They are made by the interaction of two molecular proportions of the chloroformic ester of alcohol with one molecular proportion of a diamine $NH_2—A—NH_2$, forming a dicarbamate, R—O—CO—NH—A—NH—CO—O—R, followed by treatment with formaldehyde, or a polymer and a hydrogen halide or a like compound, or a compound, the product of the combination of formaldehyde and a hydrogen halide, a dihalogenodimethyl ether. This quaternary ammonium compound has the same properties as the compound described in U. S. Patent 2,386,140, with the same method of padding and baking, and similar results are claimed. Example: A cellulose acetate fabric padded at 35° C in a solution containing 20 parts of di-octadecyl-N:N′-di-(trimethyl-chloro-ammonium-methyl)-*p*-phenylenedicarbamate and 6 parts of crystalline sodium acetate in 1,000 parts of water. The fabric picks up double its weight, is dried at 50° C, heated 2½ min. at 140° C, washed 5 min. at 40° C in a solution containing 1 part soap and 0.25 part of strong ammonia in 1,000 parts water, rinsed, and dried. The fabric is said to be soft, water-repellent, resistant to laundering and dry-cleaning. P.T.I.
Text. Research J. Mar. 1946

Quaternary ammonium salts and process of making same. Maurice A. T. Rogers (to Imperial Chemical Industries, Ltd.). U. S. 2,386,142 (Oct. 2, 1945).

This patent is similar in all respects to U. S. Patent 2,386,141. P.T.I.
Text. Research J. Mar. 1946

Knitting

Circular knit hosiery and method of making same. Harry N. Sheppard (to Scott & Williams, Inc.). U. S. 2,388,649 (Nov. 6, 1945).

An object of the invention is to make a stocking with a low heel. Advantages claimed include a smooth instep, an improved angle between the leg and foot, and an absence of puckering on the sides.
Text. Research J. Mar. 1946

Knitting Machines

Pattern chain for knitting machines. Samuel C. Doughty. U. S. 2,-388,311 (Nov. 6, 1945).

A specially constructed pattern chain designed to prevent sidewise movement of the chain buttons on the transverse bar portions of the chain links.
Text. Research J. Mar. 1946

Knitting Machine

Knitting machine. Robert H. Lawson and Paul W. Bristow (to Scott & Williams, Inc.). U. S. 2,388,750 (Nov. 13, 1945).

This invention provides improved yarn changing devices and means for feeding yarns to the needles.
Text. Research J. Mar. 1946

Circular Knitting Machine

Thomas Charles Bromley and Arthur Shortland (to Mellor Brom-

ley & Co., Ltd.). U. S. 2,385,056 (Sept. 18, 1945).

This invention relates particularly to circular knitting machines furnished with sinkers or web holders. The type of machine is one furnished with double axially opposed, i.e., superimposed needle cylinders, double-ended needles, latch or bearded, and needle operating sliders, for the purpose of enabling needles to knit in either or both of the needle cylinders. It may also be applied to single cylinder machines. P. T. I.
Text. Research J. Mar. 1946

Printing Process

Printing with leuco ester salts of vat dyestuffs. Alexis Wiazmitinow (to Sandoz A. G.). U. S. 2,389,245 (Nov. 20, 1945).

A printing paste for textiles of cellulosic nature, comprising an alkali metal salt of a sulfuric acid ester of a leuco-vat-dyestuff, an oxidizing agent, an agent capable of splitting off acid, and a catalyst and containing at least one volatile organic base which is stable towards the oxidizing agent in absence of an inorganic acid, said printing paste allowing the production of deeper and fuller shades on the textiles by a short steaming process as compared to the shades obtained by the known developing processes.
Text. Research J. Mar. 1946

Protein Fibers

Manufacture of artificial textile fibers. Robert Louis Wormell (to Courtaulds Limited). U. S. 2,389,015 (Nov. 13, 1945).

A process for increasing the resistance to the action of sodium carbonate or other mild alkalies of hardened textile fibers from casein or vegetable seed proteins.
Text. Research J. Mar. 1946

Sampling Liquids

Sampling device. Edmond T. Roetman (to American Viscose Corp.). U. S. 2,388,801 (Nov. 13, 1945).

A simple device for sampling waste liquids, solutions, and suspensions containing fibrous materials. Is intended for use in flowing liquids. The operating mechanism is outside the stream being sampled so that there is no clogging of the device.
Text. Research J. Mar. 1946

Shrinking

Shrinking of textile yarns or filaments. Frank Brentnall Hill and William Harry Kimpton (to Celanese Corp. of America). U. S. 2,388,742 (Nov. 13, 1945).

The invention is particularly concerned with shrinking such materials as yarns, filaments, ribbons, and the like for the purpose of increasing their extensibility. Shrinking is done under freedom from all tension by feeding the material into the liquid shrinking agent at a controlled rate and withdrawing at a controlled rate which is less than the rate of feeding. The liquid is made to flow in the same direction and with approximately the same speed as the material which is to be shrunk.
Text. Research J. Mar. 1946

Slippage in Knitted Fabrics

Treated fabric and method of making. Sidney M. Edelstein. U. S. 2,389,421 (Nov. 20, 1945).

The treatment consists of applying to a Raschel knitted, or similar, fabric a cellulosic film which bridges over and closes the spaces between the narrowed loops which tie the several series of warp threads together, without closing the meshes in the fabric.
Text. Research J. Mar. 1946

Spinning and Twisting

Textile mill spindle. Herman H. Brooksiecker and Paul I. Thyreen (to The Marquette Metal Products Co.). U. S. 2,388,900 (Nov. 13, 1945).

An improved spindle and braking mechanism.
Text. Research J. Mar. 1946

Stabilized Textiles

Textiles and process for making same. Carl A. Castellan (to American Viscose Corp.). U. S. 2,389,120 (Nov. 20, 1945).

By the process described in this patent, textiles can be produced which possess a permanent and predetermined residual shrinkage and the shrinkage of the fabric may be partial or complete. The process may be applied to rayon or synthetic textiles or to those made of mixtures with natural fibers. It is stated that 2 types of activatable yarns are employed. These yarns are composed of a mixture of potentially adhesive filaments with nonadhesive filaments in suitable proportions.
Text. Research J. Mar. 1946

Package Winding

Means for winding textile packages. Royal Little and Leroy Jehu (to Textron Inc.). U. S. 2,388,557 (Nov. 6, 1945).

By the use of an improved traversing means, the time required for winding is reduced, the number of turns or wraps of yarns in each layer is increased, and more yarn can be wound into a package of predetermined size.
Text. Research J. Mar. 1946

Yarn Conditioning

Yarn treating process and resulting product. Joseph B. Dickey and James G. McNally (to Eastman Kodak Co.). U. S. 2,388,833 (Nov. 13, 1945).

A conditioning process for yarns and filaments of cellulose acetate or other organic derivatives of cellulose is provided in which the essential lubricating and antistatic component of the compound consists of carboxylic amides.
Text. Research J. Mar. 1946

Yarn conditioning process. John R. Caldwell (to Eastman Kodak Co.). U. S. 2,388,826 (Nov. 13, 1945).

An improved process for lubrication of cellulose acetate yarns by use of long-chain nitriles. Lauronitrile, stearonitrile, and oleonitrile have been found to be outstanding in their ability to impart low friction characteristics to the yarn.
Text. Research J. Mar. 1946